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AN ANALYSIS OF THE SMALL AND DISADVANTAGED BUSINESS SET-ASIDE PROGRAM IN THE US AIR FORCE

THESIS

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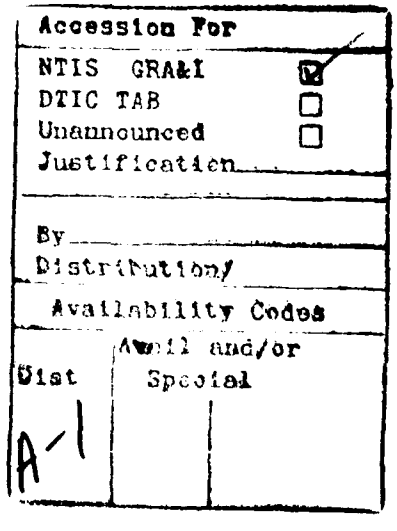
AFIT/GSM/LSY/90S-30

The opinions and conclusions in this paper are those of the author and are not intended to represent the official position of the DOD, USAF, or any other government agency.



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THESIS

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--Kenneth L. Thalmann

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Abstract

The objective of this study was to determine if the ability of Air Force organizations to contract with Small and Disadvantaged Businesses (SDBs) depended on the type of contracting effort or the type of industry or product being contracted for. The type of contracting effort was broken down into four major categories based on the Federal Supply Classification (FSC) code. The type of industry or product was broken down into five major classifications based on the Supply and Equipment Classification (SEC) code. The data to support the analysis was gathered from the Air Force Systems Command (AFSC) for the years 1987 through 1989. The objective was accomplished through a statistical analysis which included a confidence interval analysis and a pairwise comparison of means. The results showed that the organization's ability to contract with SDBs did depend on the two factors. The weakest area was electronic contracting within the supply and equipment classification. The strongest area was service and construction contracting within the aircraft and aircraft engine classification.

AN ANALYSIS OF THE SMALL AND DISADVANTAGED BUSINESS SET-ASIDE PROGRAM IN THE US AIR FORCE

I. Introduction

General Issue

Throughout its history, the US government has passed legislation designed to aid the people of our country both socially and economically. The programs created by this legislation are called socio-economic programs. Some examples of these programs are Medicaid/Medicare, unemployment benefits, social security, and farm subsidies. Another program not so well-known is the government's Small and Disadvantaged Business (SDB) set-aside program. Through this program, federal agencies such as the Department of Defense (DOD), Department of Energy, Department of Transportation, and the Department of Agriculture are now required to set aside a specified amount of their business for firms that qualify as SDBs.

The roots of this program go back to socio-economic legislation known as the Small Business Program. The Small Business Program was originally intended to allow federal agencies special purchasing provisions in order to aid businesses, which had a small chance of becoming successful

enterprises because of discriminatory practices, to compete in the US market. Since then, Congress has passed additional legislation at various times to increase the amount of business going to specific small businesses. Lately, some of this legislation has become a source of controversy because of additional requirements which were passed in 1986 and 1987 which specifically mandated the DOD attempt to set aside a specific amount (five percent) of its business for small, disadvantaged businesses.

Specific Problem

The DOD passed this goal to its respective services. As a result, the US Air Force (AF) is requiring all of its organizations to meet the goal, regardless of the types of contracting they perform, the industries they contract with, or their ability to meet the goal. In 1978, the goals were established by the head of each agency (the DOD is an agency, as is the Department of Transportation, Department of Energy, etc.) (PL 95-507:92 STAT. 1770). Then, in 1986, Congress first specified that a "fair proportion" go to each industry category as specified by the Standard Industrial Classification (SIC) code (PL 99-500:100 STAT. 1783-147). Later, they decided to make the agencies' goal equal to five percent of the total combined amounts of contracts and subcontracts in each of the four following categories:

1. procurement,

2. research, development, testing, and evaluation (RDT&E),

3. military construction,

4. operations and maintenance. (29:100 STAT. 1783-147)

Studies have been done in the civilian sector regarding this set-aside percentage. The Center for Advanced Purchasing Studies (CAPS) has shown through statistical sampling that four to five percent of the supplier base for the food service and semiconductor industries are minority owned (23:3). This implies that for some industries the goal may be realistic.

But the DOD should not be compared to these civilian industries. Merton Peck and Frederic Scherer among others have pointed out that DOD purchasing is unlike most commercial activities (21:57). Further, Jacques Gansler, in his book Affording Defense, claims that the DOD is not one big, homogeneous organization. He maintains there are dramatic differences between the various sectors of defense, and they should therefore be treated differently. (11:239-240) In addition, Congress realized there are differences in an organization's ability to meet the goal. As a result, they passed the Business Development Reform Act in 1988 creating different goals for various contract categories to determine if the category made a difference (33:102 STAT. 3890). This, combined with information from informal

interviews with SDB representatives and research performed by other researchers, indicate that in some types of Air Force contracting, such as construction and routine services (i.e., maintenance service and food services), the goal may not be difficult to meet. However, in other areas such as research and development and electronic production, the goals may be extremely difficult to meet. And, if this hypothesis is true, that is, if it is more difficult for some contract categories to meet these goals than others, then perhaps the factors prompting these differences can be determined.

There has never been objective research conducted to determine whether or not there is a difference based on the contracting category or type of industry contracted with. Therefore, this study was performed to examine the ability of different AF organizations to meet the specified goal based on contracting categories and type of industry.

Research Questions

More specifically, the study attempted to answer the following question:

> Does the ability of AF organizations to meet the five percent goal depend on contracting categories?

This can be answered through the following specific research questions:

1. Does the percentage of contract dollars going to SDBs meet the five percent goal, given the type of

contracting effort and the specific industry or product classification?

2. Does the percentage of contract dollars going to SDBs significantly vary between category of contract effort and equipment/industry classification?

Scope of Study

This study was limited to investigating the abilities of only the Air Force Systems Command (AFSC) agencies to meet the goal. It was originally intended to study all the AF agencies but this data was unavailable. It included prime contracts with the SDBs and SDB contracts with the Small Business Administration (SBA). It also included contracts with Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI). It did not include contracts derived as a result of the Small Business Innovative Research Program because this method of contracting was not included in the Congressional mandate.

When analyzing this area, one must realize AF contracting can be classified in many ways. In fact, there are hundreds of categories of contracts. These categories are not necessarily mutually exclusive. This study was primarily interested in contracts applicable to the AF but one of the hurdles was to determine how to separate the contracting categories into applicable groups.

Fortunately, the data system used for the information in this study had broken down all the AF contacting types into

appropriate groups. The first group is based on the Federal Supply Classification code or FSC code. This breaks the contracting types into three main groups--(1) Research Development, Test, and Engineering (RDT&E), (2) Other Services and Construction, and (3) Supplies and Equipment. These categories are appropriate for this study for two reasons. First, they break the contracting types into categories which Congress stated were substitutable for the Standard Industrial Classification (SIC) codes they are interested in (38:1773). Second, the categories are stratified sample groups which may have significant differences in their ability to meet the five percent goal. The other category is the System or Equipment Classification code (SEC code). The main categories are aircraft, aircraft engines, missiles and rockets, vehicles, weapons, ammunition, electronics, and other equipment. These categories are useful because of the interrelationship to the FSC categories and their similarity to the different divisions within the AFSC. For instance, the Aeronautical Systems Division (ASD) deals primarily with Aircraft and Aircraft Engines, the Space Systems Division (SSD) and Ballistic Missile Division (BMD) deal primarily with Missiles and Rockets, the Munitions Systems Division (MSD) deals primarily with the weapons and munitions and the Electronic Systems Division (ESD) deals with the electronics. The interrelationship of these categories can

be represented as shown in Figure 1.

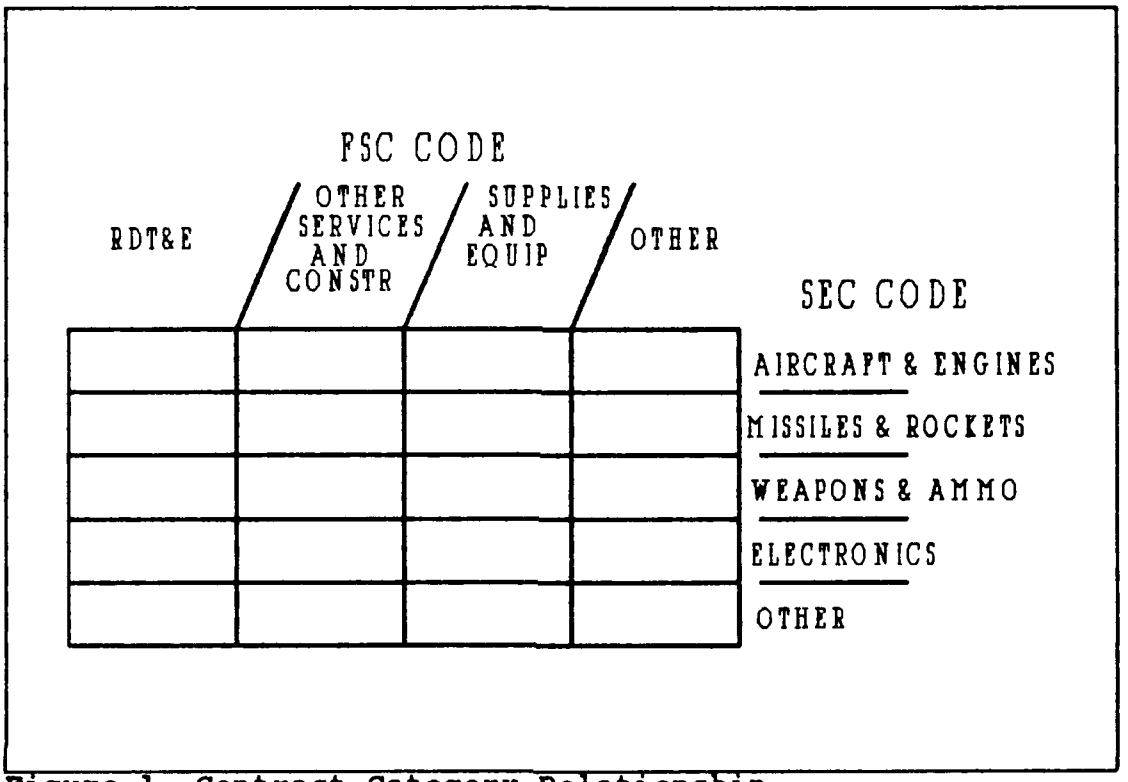


Figure 1 Contract Category Relationship

Limitations

When evaluating the results and conclusions of this research, several limitations should be considered. The AFSC contracting policy may be unique to the AF and other DOD services. Even though AFSC contracting follows the federal contracting guidelines set forth in the Federal Acquisition Regulation (FAR), it follows more specific guidelines according to the DOD, AF, and AFSC supplements to the FAR. Other organizations may divide their contracting

disciplines differently, especially outside the DOD. Within the DOD there is greater standardization, however, some caution should be exercised when associating the results of this research to other AF, service, or Federal agencies.

Definitions

The terms frequently used throughout this proposal are defined as follows:

Small Business: A business which is independently owned and operated, not dominant in the field of operation in which it is bidding, and meets certain size requirements. This depends on the type of industry the business is in. For example, in the construction industry, small business status depends on the average annual receipts of the business whereas in the manufacturing industries it depends on the number of employees of the business and its affiliates (1:6-4).

Small, Disadvantaged Business: A small business which meets the preceding requirements (depending on its type of industry), is at least 51 percent owned by one or more socially and economically disadvantaged individuals, or a publicly owned business with 51 percent or more stock owned by socially and economically disadvantaged individuals, and is managed and controlled by one or more such individuals

(12:150). Women-owned businesses, for the purposes of this research, are not included in this category.

Small Business Owned and Controlled by Socially and Economically Disadvantaged Individuals: The same as Small, Disadvantaged Businesses (27:92 STAT. 1762).

8(a) Business: A subgroup of the small, disadvantaged businesses which are participating in the SBA's 8(a) program (so called because of section 8(a) of the Small Business Act). These businesses can only be eligible in the program for a fixed period of time (eight years). When a federal agency contracts with these businesses they actually subcontract to the 8(a) business through the SBA.

There are many advantages for participating in the 8(a) program. First, it allows the business to get exposure which it might not have gotten otherwise. Second, it allows the SBA to immediately single out the business for consideration if the SBA thinks they are eligible for the contract. Third, it allows the businesses special contracting assistance from the SBA.

Thesis Overview

A literature review to review the background and some economic theory of SDB legislation follows this chapter. The methodology for the research is described in detail in

Chapter three. Chapter four presents the findings and analysis of the research. Finally, the conclusions of the research and some recommendations resulting from the research are covered in the last chapter.

II. Literature Review

Introduction

Socio-economic programs in general and SDB programs in particular have generated considerable attention during the last two decades. As a result, the literature on this subject is extensive. Potential sources of information ranged from editorial type articles to empirical research. This literature review is limited to background information, legislation, expert testimony, and research related to small business and SDB programs, especially as they related to DOD and AF involvement in meeting SDB goals. This literature review limited its scope to only the AF's and related organization's participation and placed greater emphasis on sources which substantiated their facts as opposed to literature providing editorial or speculative assessments. This literature review consists of a brief legislative history and background on the subject, an economic analysis, arguments for and against the legislation, a brief analysis of the effectiveness of the program, and a discussion of some alternatives.

Background

When reviewing this program, one must keep in mind that even as far back as 1865, federal acquisition was used tc

implement socio-political programs. At that time Congress mandated that only American bunting could be purchased and American labor and materials were preferred for public improvement contracts (26:41). However, the legislation which pertains to this study dates back to 1953 when Congress created the Small Business Administration (SBA) with the passage of the Small Business Act. This legislation attempted to help those businesses which had a small chance of becoming competitive because of their size.

In 1978, Congress passed PL 95-507, Amendment to the Small Business Act of 1953. The intention was to start a socio-economic program which would make up for past discriminatory practices against minority groups such as women, blacks, and hispanics, among others. Previously, most of the small business legislation emphasized small businesses, not necessarily small, disadvantaged businesses. This law was also supposed to allow these groups, which traditionally own a disproportionately small portion of the businesses in the US, to have a chance to become viable competitors in the US's free enterprise system. The law itself states:

> ...it is therefore, the purpose of section 8(a) to-
>
> '(A) foster business ownership by individuals who are both socially and economically disadvantaged,
>
> '(B) promote the competitive viability of such firms by providing such available contract, financial, technical, and management assistance as may be necessary; and
>
> '(C) clarify and expand the program for the procurement

> by the United States of articles, equipment, supplies, services, materials, and construction work from small business concerns owned by socially and economically disadvantaged individuals. (27:92 STAT. 1760-1761)

The US senate further clarified the law and reported the following:

> The purpose of the 8(a) program is to foster the development of socially and economically disadvantaged businesses and to promote the competitive viability of these businesses by providing necessary contract, financial, technical and management assistance. (3:5600)

Some chief provisions of the act were: (1) it included socially disadvantaged individuals into the program, (2) it allowed the SBA to contract with the SDB's, (3) it increased the dollar amount going to Small Businesses through subcontracts with federal agencies, and (4) it established goals which could be set by the heads of federal agencies and the administration (35:5603, 27:92 STAT. 1770). Unfortunately, in the article "Socioeconomic Contract Goal Setting Within the Department of Defense: Promises Still Unfulfilled", Dennis Black, demonstrates that neither the implementation of the law nor the five percent goal accomplished the intended results (3:67-82). Arthur King also confirmed this in his doctoral thesis (10:16).

In 1982, Congress passed the Small Business Innovation Development Act, which established the Small Business Innovation Research Program (SBIR). This legislation aimed at R&D business development had four objectives:

1. stimulate technological innovations,
2. use small businesses to meet federal R&D needs,

3. foster and encourage participation by minority and disadvantaged persons in technological innovation,

4. increase private sector commercialization innovations derived from federal R&D. (28:196 STAT. 217)

However, when Congress reviewed the original proposal, the DOD, NASA, the DOE, and the SBA were against the one percent set-aside for small businesses because it would reduce their flexibility (36:521). Nevertheless, Congress passed the proposal anyway (36:523).

Then, in 1986, Congress took major steps towards improving the effectiveness of PL95-507. Through the Defense Appropriations Act and the Continuing Appropriations Acts for Fiscal Year 1987 (PL99-661, PL99-500, and PL99-591 respectively), Congress specified that a "fair proportion" of the federal agency's money go to each industry category as specified by the four-digit SIC (Standardized Industrial Classification) code (31:100 STAT. 3927). Strangely enough, the joint committee reviewing the resolution had no comments on this portion. However, later, in the Defense Appropriations Act, the House wanted to mandate ten percent of the DOD's dollars in each of the following four areas to set aside for SDBs, HBCUs (Historically Black Colleges and Universities), and MIs (Minority Institutions): (1) Procurement, (2) RDT&E, (3) military construction, and (4) operations and maintenance. At this point SDBs, HBCUs, and MIs were labeled Section 1207(a) entities because they were

specified as such in Section 1207(a) of the resolution. However, the Senate softened the legislation by dropping the mandate, making it a goal instead, and cutting the ten percent back to five percent. This is where the DOD gets it five percent goal today. At the same time, the Senate agreed to allow less than full and open competition for competing the set-asides and allowed the contracts to cost up to ten percent more than the fair market value of the contract (31:6583-6584).

The next year, in the Defense Appropriations Act for Fiscal Year (FY) 1988, Congress mandated that the DOD make substantial progress for awarding contracts to section 1207(a) entities (32:101 STAT. 1126). The House also clarified that federal agencies could group the SIC codes to establish their annual goals (38:1772). This was a result of an extreme difference in set-aside amounts depending on which SIC codes were used for refuse collection (32:101 STAT. 1126). At the same time they realized existing federal classification codes such as the Federal Supply Classification (FSC) code were similar to, and could accomplish the same objectives as, the SIC codes. Therefore, they also allowed a correlation between Federal Procurement Data System (FPDS) codes and SIC codes (38:1773).

In 1988, Congress passed the Business Development Reform Act, the purpose of which was to demonstrate:

> (1) the competitive capabilities of small business firms in certain industry categories will enable them to

> successfully compete on an unrestricted basis for federal contracting opportunities,
>
> (2) the use of targeted goaling and management techniques by procuring agencies in conjunction with the Small Business Administration, can expand small business participation in Federal contracting opportunities which have been historically low, despite adequate numbers of qualified small business contractors in the economy,
>
> (3) expanded use of full and open competition, adversely affects small business participation in certain industry categories, taking into consideration the numerical dominance of small firms, the size and scope of most contracting opportunities, and the competitive capabilities of small firms. (33:102 STAT. 3890).

Basically, this legislation enhanced small business (note: not SDBs) participation goals to 40 percent in groups with historically low rates of small business participation and large numbers of qualified firms (33:102 STAT. 3890-3891). The groups of interest are: (1) construction (SIC codes 15XX, 16XX, and 17XX), (2) refuse systems and related services (4212, 4953), (3) architectural and engineering services (7389, 8711, 8712), (4) non-nuclear ship repair (SIC code not specified), and dredging (SIC code not specified) (37:5478). The requirements are the same for all of the categories except dredging which had a phase-in period of participation goals. The previous goal for small businesses was 20 percent. The interesting part here is the fact this legislation was a result of a survey done among 8(a) program "graduates" (businesses which had finished the program after eight years). This survey showed two main problems (37:5404, 5406). The first problem was there were

shortcomings in the day-to-day operations and the long term effects of the program. The second problem was the program was viewed more as a contracts program, not as an opportunity to develop the business. The second problem conflicts with one of the main purposes of the program.

Most recently, in the Defense Appropriations Act for FY 1990, Congress mandated the DOD to increase resources and the number of personnel to help promote and assist SDBs to gain an equal chance to provide commodities and services and allowed work done on indian lands to count as part of the goal (34:103 STAT. 1129).

Two sources suggested reasons for DOD involvement in this program. Dale McNabb et al., in their article "On the Utilization and Degradation of the DOD Acquisition System for Socio-Economic Policy Implementation," state that the DOD must be used since their portion of governmental outlays is so large (18:22). Also, B.R. Gamble's research study of the AF's participation in the 8(a) program explains that the DOD must be used because it is the "'big spender'" of federal agencies and goes on to point out that the DOD was the largest single item in federal outlays until 1974 (10:12).

Realizing this fact, the AF started a program before any of these laws were enacted. Major General Stansberry of the Air Force Systems Command (AFSC) explained that the AFSC encouraged the use of Minority Business Enterprises (MBE)

one year before PL 95-507 was passed. He asserted that the entire command was instructed to contract with MBEs as much as possible (25:40-43). Other examples of Air Force support for the program include a letter from the Commander in Chief of the Military Airlift Command and yearly statistics showing Air Force support (10:atch 1; 3:67-82).

Based on the previous section, there has been much analysis on the social aspect of this legislation. However, how does this legislation affect the players economically?

An Economic Analysis

In this section this analysis will discuss the economic aspects of this program as it relates to the DOD. The reader should bear in mind, though, that this program applies to all federal agencies. The analysis will address the theory behind socio-economic programs such as the SDB set-aside program, the DOD's economic market and the program's effect on it, and some economic obstacles the SDBs have in the DOD market.

Theory of Socio-Economic Programs. Observations on the role of government and socio-economic programs in a capitalist economy such as the US's have been made since its founding. James Madison, one of the founding fathers of our country, believed a capitalistic system would lead to a need for regulation because of basic human nature:

> Those who hold and those who are without property have ever formed distinct interests in society. . . . A landed interest, a manufacturing interest, a mercantile interest, a moneyed interest, with many lessor interests, grew up of necessity in civilized nations, and divide themselves into different classes, actuated by different sentiments and views. The regulation of these various and interfering interests involves the spirit of party and faction in the necessary and ordinary operations of government. (2:43-44)

More recently, Edward Chamberlain, in his essay "Product Heterogeneity and Public Policy," also remarked: "Public policy must be presumed to seek in some sense the general welfare, and hence in the economic sphere it implies a welfare economics (4:236)." Chamberlain goes on to point out we wish to approach a workable competition in society through these welfare programs (4:236-237). If it can be assumed these programs improve the spirit of the people, Gansler also infers the importance of these programs when he states "the social unity and political resolve . . . of the public to deploy and support forces . . .is crucial (11:19). These programs are also important because they help drive the system to satisfy the three necessary conditions, which, according to Edwin Mansfield, in his book Microeconomics, Theory and Applications, allow for optimal resource allocation in an economic system: (1) the marginal rate of substitution between any two commodities must be the same for any two consumers, (2) the marginal rate of technical substitution between any two inputs must be the same for any pair of producers, and (3) the marginal rate of substitution

between any two commodities must be the same as the marginal rate of product transformation between two commodities for any producer (17:470-472).

Based on these insights, it is possible to conclude that in our free enterprise society, not only do we need these socio-economic programs for people in the society, but for the economic system as well. Keeping this in mind, how does the DOD and the SDB set-aside program solve this need?

The DOD and SDB Set-Asides. The program is designed to make up for past discriminatory practices in the US and to increase competition in the free enterprise system. As Madison pointed out, there are, were, and will continue to be different factions of wealth in this country. Gordon Bjork points out in his book, Private Enterprise and Public Interest: The Development of American Capitalism, that minorities, especially blacks, have not been equally treated in the US (2:221-225). Therefore, in the US's interest it is necessary to use socio-economic programs to make up for these.

As stated earlier, the DOD is an obvious choice for the implementation of this program because of its immense portion of the federal budget. In 1988, the defense portion of the budget was 25 percent (11:79). How does this program interact with the DOD economic market? To determine this, the DOD market structure must first be defined.

The defense industry currently has relatively few actual

suppliers. There are thousands of small firms in the market, but their impact is minimal since they are mostly subcontractors to the few large firms the DOD deals with. For example, consider the high concentration of business given to the top four defense firms in the various sectors of the defense market as shown in the Table 1.

Table 1

Percentage of Defense Market
for Four Largest Defense Contractors (11:246)

Portion of Defense Market	Percentage
Surveillance and Satellites	100
Nuclear Submarines	99
Space Boosters	97
Fighter Aircraft	97
Attack Aircraft	97
Missile Inertial Guidance Systems	97
Aircraft Inertial Navigation Systems	96
Missile Reentry Vehicles	95
Aircraft Fire Control Systems	95
Transport and Tanker Aircraft	94
Helicopters	93
Jet Aircraft Engines	93

Although this does not cover the full spectrum of the DOD's business, it substantiates the point that there are only a few substantial suppliers in the DOD market. Based on this information, a single buyer and few suppliers, the DOD market structure could be classified as a bilateral monopoly, a monopsony, or an oligopoly. Some even say the DOD market is so unique with respect to weapon systems it has no market structure at all (21:55). The following

analyzes these possible market structures.

Jacques Gansler points out in his book, Affording Defense, that for any given weapon system, there is only one buyer and one or two suppliers (11:246). This appears to be a possible bilateral monopoly since a bilateral monopoly consists of one buyer and one seller. However, according to Frederic Scherer, in his book The Weapons Acquisition Process: Economic Incentives, two firms may be enough to keep it from being a bilateral monopoly. He states that for optimal incentive effects the number of competitors only needs to be large enough that there is a real threat of cancellation (or losing) the contract (24:48). According to this view, as long as there is enough competition to preclude a monopoly with respect to suppliers, a bilateral monopoly may not take place.

According to Edwin Mansfield, the defense industry is an oligopoly (17:337). However, with a single buyer (the federal government) a true oligopoly cannot exist since it requires a multiple buyer market (a demand curve which cannot be changed or influenced by one individual or firm). The government certainly controls the demand curve in the defense industry. Therefore, would be oligopolist firms in the defense industry cannot control the market as they would in a true oligopoly.

A monopsony is a situation in which there is a single buyer. Although this is the case in the defense industry it

may not be a true monopsony because the sellers may be able to use an alternate market to sell their goods. Some of the larger, more diversified sellers can sell their services and manufacturing skills to the civilian industry market, so they are not dependent on the single buyer (the government).

On the extreme, Merton Peck and Frederic Scherer believe no market structure exists at all with respect to weapon systems in the defense industry. They claim that in a market: (1) the seller initiates the decision to produce and the buyer then decides to purchase, (2) prices are determined by competition, not cost and fair return, and (3) there are decentralized decisions on what to produce and price, and since the defense industry doesn't meet these criteria it has no market structure in the traditional sense (21:55-57). According to Mansfield, a market is a "group of firms and individuals in touch with others in order to buy or sell some goods (8:20)." Although this definition is generic in nature, it still points out that with buyers and sellers involved we have a market. And, with a market we must have some structure since we have interaction between the buyers and sellers. Albeit it may not be well defined and accepted structure, it is one nonetheless. In addition, this researcher disagrees with Peck and Scherer's analysis because all of their elements of a market can and do take place in the DOD industry. Only in the case of major weapons acquisition do all the elements not exist.

If the defense industry isn't a bilateral monopoly, oligopoly, monopsony, or non-market structure, what is it? It is a combination of oligopoly and monopsony which creates a unique market structure ruled by a single buyer whose demand supports a supply by a limited number of firms. As such, the demand curve is relatively inelastic, since price is not really much of a driver in determining what (or how many) of an item is bought. And, the supply curve is also relatively inelastic for the same reasons in addition to the fact there are no close substitute goods.

With this type of a market structure, what are the effects of the SDB set-aside program? Three of the possible effects are lower costs, increased competition and a reduced chance of collusion.

One of the economic goals of the program is to increase the competition in the defense industry and thus lower costs. With basic economic theories, one can show that as one increases competition, in general, costs are lowered (17:324). This is due to the price of goods approaching the optimum price where supply equals demand rather than an optimum price established by a firm or firms where marginal costs equal marginal revenue (as in the case of a monopoly). This is a desired additional economical benefit of the SDB set-aside program.

Another hoped-for benefit of additional competition through the SDB set-aside program is the reduced chance of

collusion taking place. Earlier, the analysis showed that as long as there are two suppliers, and the belief that one may lose the contract, there is sufficient competition. This assumes no collusion takes place or cartels are formed. Obviously, an increase in the number of firms in any one industry will lessen the chance of collusion taking place or cartels forming.

But, these benefits may not occur in this case. Walter Culver, in his article "The Federal Small Business Program: Does it Really Serve the National Interest?", implies that the SDB set-aside program hurts competition rather than helps it because the program encourages the SDBs to stay small through its regulations (5:24-25). This was also verified in Senate Report Number 100-394, during the review of Public Law 100-656, the Business Development Reform Act (33:5406). And, in order to enter the competitive markets in the defense industry, the SDBs will have to invest substantially in the capital to acquire and maintain equipment in order to become viable competitors. This cost could be extraordinary and would likely be paid for by the government through increased prices on contracts. In addition, Gansler points out these SDBs usually have cost overruns, late deliveries, and then default on contracts forcing them to ask the government for relief (11:262).

Another factor to consider is the impact of variable defense funding by Congress. If, during a time of high

defense funding, the industrial base is increased by adding these highly specialized SDBs, who will be hurt the most during a period of reduced funding? It will probably not be the relatively diversified major contractors but the highly specialized SDBs, which could cause an increased burden on the welfare system through unemployment.

In addition to all of these, the contracting agencies are allowed to pay up to ten percent more than a fair market price, thus possibly driving the prices up even further. Therefore, the program does not necessarily increase competition and reduce costs.

Obstacles for SDBs in the DOD Market. Since the defense industry is a pseudo-oligopolist market, the barriers to enter an oligopolist market need to be considered. According to Mansfield there are three main barriers:

1. size of the market relative to the size of the firm,
2. building and maintaining a large, complicated, and expensive plant, and
3. unavailability of natural resources (17:354).

The second point has already been discussed. The third point is relative in terms of labor as a natural resource. The first point is more important. The firms must be able to cover all their costs. Once enough firms exist to drop the individual demand curve below the average cost curve, an effective barrier to entry exists (17:354).

There are other, more specific barriers to entry, though. Gansler discusses the following:

1. brand loyalty by services,
2. need for high levels of engineering and scientific capabilities (a more specific case of Mansfield's third barrier),
3. need for large cost reserves,
4. specialized reporting requirements,
5. required knowledge of the detailed federal regulation,
6. security clearances, and
7. political considerations. (11:246)

All of these barriers cause additional difficulty for the SDBs to enter the market. In addition, Gansler points out barriers to diversification, leading to problems discussed earlier with respect to funding levels (11:246).

Conclusion Even though Congress has implemented socio-economic legislation via the SDB set-aside programs to help the economic situation of these SDBs, and these socio-economic programs are necessary, the SDB set-aside program does not have sound economic logic. First, because of its unique monopsonistic-oligopolistic structure, the DOD is not a market in which set-asides are necessarily advantageous. The SDBs may not lower costs, increase competition or reduce the possibility of collusion--all desired benefits of the program. Second, there are numerous and large barriers to enter the defense market, not only those usually identified with an oligopolistic market but additional ones specifically associated with the defense industry. This makes it even harder for the program to

achieve its economic goals. In addition to these defense related obstacles, there are other, more general, impediments as well.

Impediments to SDB Use

One study revealed that there are a number of impediments to using SDBs. In the report entitled Purchasing From Small Minority-Owned Firms: Corporate Problems, Marc Dollinger and Catherine Daily show that there are four chief impediments to MBE (minority business enterprise) use. They are (in order of importance): (1) business uncertainty, (2) small numbers, (3) opportunism, and (4) atmosphere (7:13). The results of the study also show that the following four impediments were not problems when dealing with MBEs: (1) impacted information, (2) resource dependence, (3) complexity, and (4) product uncertainty (7:13). The three types of firms surveyed for this information were; large corporations, small businesses, and MBEs. Although the combined sample showed that the number one problem with conducting business with MBEs was due to small numbers, the ratings by individual group were different. To the corporations, the largest impediment was complexity (7:14). They also scored higher than the other groups in the small numbers, business uncertainty, and production uncertainty categories (7:14). However, the MBEs thought complexity, opportunism, atmosphere, and impacted

information were larger factors (7:14). As a result, not only are there DOD specific impediments to SDB use but general impediments met by civilian businesses as well.

Advantages/Disadvantages

The literature revealed some advantages and disadvantages of the SDB program. The advantages of the program are innovation, an increase of the industrial base, and the ability to make up for past discrimination. Some of the literature showed that innovation can be an especially good benefit of the program. Steve Edelmann's article, "What Makes America Great," advocates more involvement of 8(a)s in DOD research and development (R&D) because 25 percent of all PhD diplomas awarded to scientists, engineers and such were awarded to members of minority groups that could qualify as 8(a) business owners (8:32). In addition, Dr. Yale Lubkin points out several historical examples of successful companies which started as small, innovative companies. One example he gives is Edwin Land joining the Haloid company to form Xerox (15:34).

Likewise, another advantage of the program is to increase the industrial base. Senator Alan Dixon, D-IL, states: "The security of the United States is dependent on its industrial base however, and small business must be encouraged to participate if we are serious about maintaining our technological advantage, whether in peace or

war (6:14)." And, as one would hope, since it is the ultimate goal of the program, the program can possibly make up for past discrimination. Arthur King, in his study on the 8(a) program and the AF, concluded "the 8(a) Program has been somewhat effective in alleviating one aspect [past discrimination] of the economic underdevelopment problem of the United States minority group sector" and has helped a limited number of minority group businesses (10:16).

But, the research shows there are some disadvantages, too. The chief disadvantages are increased prices, increased completion time of acquisitions, and increased costs. John Magnotti's study of the SBA's pilot program with 8(a)s that:

> Congress is being used to generate legislation that runs from ineffective to damaging to all parties concerned: the minority business establishment, the contractual programs involved, and the majority contractors caught up in contractual actions 'reserved by the SBA.' (16:64)

Comparable to this is Timothy Bates' research which shows government contracting officers contend buying from 8(a) firms usually produced low performance and late deliveries (14:38). In addition to this, extra costs are incurred from the program.

The extra costs incurred include the basic cost of running the program. Congress did an estimate during the analysis of PL 95-507 to see how much the administration of the program would cost. The total cost was estimated to be $35.6 million (13:5615). Plus, the DOD is authorized to pay

up to ten percent more than the fair market price for contracts set aside for an 8(a) business. Thirdly, Black points out that the costs of hiring an 8(a) business are greater than any contractor might receive for subcontracting to the 8(a) business (3:78).

Effectiveness

There is much information pointing out the ineffectiveness of the program. Black points out several examples of the program's inability to accomplish its goals. He shows there has been no significant increase in the share of dollars going to the 8(a)s (3:80). He also states "there is no evidence to date that such use of an agency's contracting process . . . is an effective means of reducing socioeconomic discrimination in society (3:80)." And, he claims the program has not significantly increased the share of federal dollars to 8(a) businesses (3:81). Lorette et al., propose the program is actually a hinderance to the companies. They claim too much effort has been directed towards obtaining contracts and not towards "teaching the skills required to complete the contract and to stay in business (14:39)." Walter Culver also points out that the program hurts competition rather than helping it and the program encourages small businesses to stay small (5:24-25).

Based on the previous discussion, it is evident there is much effort towards increasing SDB's share of the business

in this country, however, it is not effective effort. There must be some alternatives to make the system work better.

Alternatives

Many of the articles had proposed alternatives. Increased incentives rather than mandated goals, subcontracting rather than set-asides, and reserving specific amounts in specific areas of the federal business for 8(a)s are three suggested alternatives. Black, Culver and Magnotti believe giving government agencies and contractors more incentive to contract with 8(a)s will be more effective (3:81; 5:25; 16:64). Edelmann believes the government should concentrate on increasing 8(a)'s share of subcontracting while McNabb believes the government should reserve a certain amount of the contracting fcr the 8(a)s rather than a five percent requirement across the board (8:32; 18:26).

Dollinger and Daily listed nine recommended activities for aiding MBEs. They are (in order of importance): (1) search for corporations, (2) monitoring of MBEs, (3) managerial assistance for MBEs, (4) searching for MBEs, (5) cultural interaction, (6) monitoring of corporations, (7) internalization, (8) technical assistance, and (9) financial assistance (7:13). It is interesting to note, especially since the MBEs participated in this survey, that financial assistance is at the bottom. The most recommended

activities are administrative functions which the SBA should do.

Conclusion

Clearly, based on the literature reviewed, this program to help 8(a) businesses, derived from Public Laws 95-507, 99-601, and 100-180, is not as effective as it could be. This study performed a quantifiable analysis to determine whether there are certain contracting categories and equipment/industrial classifications which impact the AF's ability to meet the five percent goal. If the analysis shows the program is not accomplishing its goals, then some better alternatives, or possibly a different program altogether, should be implemented which will accomplish the goals.

III. Methodology

Introduction

The focus of this research was to assess the ability of Air Force organizations to meet the five percent Small and Disadvantaged Business (SDB) goal established by Congress for Federal Agencies. Specifically, it sought to determine whether the type of contracting effort and the type of industry or product involved impacted the organization's ability to meet the five percent goal. In order to do this, the following two research questions were examined:

1. Does the percentage of contract dollars going to SDBs meet the five percent goal, given the type of contracting effort and the specific industry or product classification?

2. Does the percentage of contract dollars going to SDBs significantly vary between category of contracting effort and equipment/industry classification?

This chapter presents the methodology used to answer these questions. The criteria for methodology decisions were as follows: (1) the data gathered should be as complete and accurate as possible, (2) the analysis should use proven statistical methods to examine the data, and (3) the inferences drawn should be accurate, well founded, and have a high degree of confidence.

This chapter first presents the classification of research and reviews the experimental design. It then

discusses the research data, including the data source, measurement techniques associated with the research, the validity of the research, and the manipulation of the data. Next, it briefly considers the theory and application of the statistical analysis accomplished.

Classification of Research

This was a formal study since it conducted hypothesis testing on the research questions using analysis of variance and pairwise comparison techniques. It was observational in nature since the outcome depended on available data obtained through an Air Force Systems Command database. It was also *ex post facto* since there was no control over the variables in the study. The study had a descriptive purpose since the research was concerned with how different categories of contracting efforts and equipment/industrial classifications affect the ability of an Air Force organization to meet the five percent SDB goal. The study was cross sectional in nature since it examined only contracts awarded since 1987, the year after the Congressional mandate was passed.

Experimental Design

This study was a quasi-experiment because it used observational data and had no control group to compare results against. The experimental design was a two-factor

analysis of variance as depicted in Figure 2.

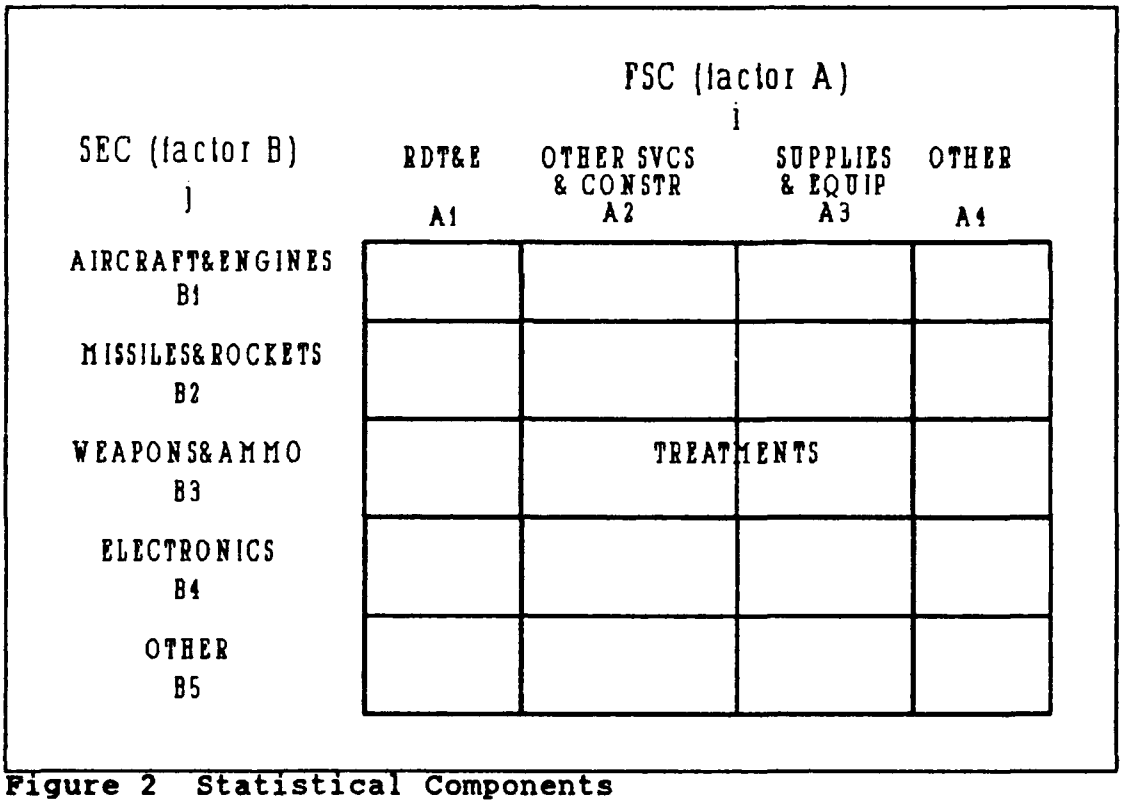


Figure 2 Statistical Components

The first factor classified a contract by type of contracting effort. The Federal Supply Classification (FSC) was used to determine four factor levels, which for this study included (1) Research, Development, Test, and Evaluations (RDT&E); (2) Services and Construction; (3) Supplies and Equipment; and (4) Uncoded. Uncoded entries were either difficult to classify clearly into one of the categories or were not coded due to error. The second factor categorizes the type of equipment or industry involved. The study narrowed nine major Supply and Equipment (SEC) categories to five because some of the

categories (i.e. Aircraft and Aircraft Engines, Weapons and Ammunition) were closely related. The five factor levels were: (1) Aircraft and Aircraft Engines, (2) Missiles and Rockets, (3) Weapons and Ammunition, (4) Electronics, and (5) Other (which included vehicles, ships, and uncoded entries). The data points which had no SEC code were also included in the "Other" category. The treatments for the study were the combinations of the two factors (i.e., Electronics and Supplies and Equipment). The dependent variable for the study was the proportion of contract dollars awarded to SDBs for each treatment.

Data

Data Source. The data was obtained from the AFSC Acquisition Management Information System (AMIS) database, located at Wright Patterson AFB, OH. This computer database contains all the information from DD Forms 350 relevant to AFSC. The major sorting factor was the Federal Supply Classification (FSC) code and the minor sorting factor was the Supply and Equipment Classification (SEC) code. See Figure 3 for a representation of the data from the data base. Notice in the figure the FSC codes are broken down in terms of four classifiers (the four digits). The SEC codes are broken down in terms of three classifiers. These more detailed classifications served as the observational elements which went into the treatments of the study. The

treatments consisted of the first digit or classifier, and in some cases, a combination of these first digits. The "Total" rows were not included as datapoints.

SDB Business
Fiscal Year 1987

FSC	SEC	Obligation	SDB Obligation	Percent/100
AC14		$10, 789	$10,789	1.000
	ABC	$1,544,624		0
	ABH	$157,404,947		0
	ACR	$8,799,279		0
	ADG	$21,077,030		0
	AFF	$22,275,753		0
		.		
		.		
		.		
	000	$664,283,480		0
Total		$982,529,971	$10,789	0.0001
		.		
		.		
		.		
9999		$528	$528	1.000
	000	$40,753,101		0
Total		$40,753,629	$528	0.0001

Figure 3 Typical Data From AMIS Database

There were some anomalies in the data. There were blank SEC codes and some SEC codes were listed as "000". It is unknown whether the coding was deficient or the nature of the contract made no code appropriate. These anomalies were common in the data and resulted in an overwhelming amount of the data (69 percent) falling into the "Other" classification in the data analysis. If these datapoints would have been in the titled classifications they may have added to the knowledge about those classifications. There

were also some datapoints which had missing FSC codes but these were few (eleven total).

Even though these anomalies are present and there are potential sources of error, the error in the study should be minimal since the individuals dealing with it were professionals and there were many checks against error in the system.

Measurement. The data scale type involved in this study is ratio since it consists of the dollars which went to SDBs divided by the total contracting dollars for each specific treatment. The data range from -.9351 to 2.235. In the cases where the percentages of dollars was greater than 100 or less than 0, the SDB dollar amount was most likely either greater than the total dollar amount in that contracting category because some of the non-SDB contracts had money removed from a contract (a negative obligation) or some of the SDB contracts had money removed.

Since the data for this study already existed and is not being gathered under experimental conditions, it is secondary data. The advantages of secondary data is that it is quick to access and collect and it is relatively cheap. However, this is at the expense of accuracy and consistency With secondary data one has to assume the accuracy of it since it was not gathered and assembled under carefully controlled conditions. Another possible drawback with secondary data is controlling error.

Error. In terms of data error two basic sources were of concern: human and instrumental. In this study human error could have been introduced in a variety of ways. The initial coding of the information onto the form at the initiation of the contract could be in error (i.e., wrong code, dollar value, type of business, or other pertinent information). When the form reaches the person responsible for entering the data into the database, that person could make the same mistake. Or, when the analysis is conducted on the information retrieved from the database, the researcher could make the same errors.

Government quality control procedures should minimize these errors. The database was assumed to be correct because the researcher has no method to verify or test its accuracy. In terms of the researcher's inputs, the data was checked and cross-checked for accuracy.

The other type of error, instrument, could be caused through programming errors in the information retrieval or through format inconsistencies with the requirements of the study. Also, if the statistical package analyzing the data were to err during the analysis (i.e., inappropriately applied statistics due to violated statistics), it would introduce instrument error into the analysis. As best as the researcher could determine the formats were all perfectly compatible and the statistical packages correct. Care was taken to use appropriate techniques, however,

conditions were violated which degraded the validity of the statistical inferences. This will be discussed in more detail in the Statistical Analysis section.

Validity. There are two types of validity for data and analysis: external validity, or the interaction of the treatment with other factors and the resulting impact on abilities to generalize across time setting or groups, and internal validity, or the truthfulness of conclusions drawn (9:115). They both have unique characteristics and can threaten the validity of the study if not accounted for.

External validity can be threatened in two ways. The first threat to validity is interaction. If the data collected is interactive, then one of the treatments has an effect on the other. If, during the analysis, assumptions are made and conclusions are drawn about the main factors, the conclusions may be invalid if one has not accounted for interaction. This posed a problem in this study and is addressed in detail in the in the Statistical Analysis section.

The second threat to external validity is data selectivity. If the data is selective in nature; e.g., choosing specific groups to analyze in stead of the total database, then the results will also be invalid since they cannot be generalized across time, settings or groups. This study used selective data (AFSC data for 1987-1989) and therefore may not be generalizable outside of the AFSC or

the years included in the study (1987-1989).

In terms of internal validity, the points mentioned earlier regarding error in the data are applicable. Any sources of error in the data will affect the internal validity. In addition to this, there are other items affecting internal validity which must be addressed.

Any changes in data collection can affect internal validity. For example, the DD Forms 350 changed format during the period of time under study. However, the portions affecting this study did not change. No other changes occurred which could impact the internal validity of this study.

The computer and statistical analysis can affect internal validity, too. If the computer or the statistical analysis are not as accurate as the study dictates, error will be introduced and validity will be threatened. Since this study will require a relatively simple Analysis of Variance (ANOVA) and generally accepted statistical software was used, this was not a problem.

Accuracy of the data can be a threat to internal validity, also. If the data in the database does not accurately reflect the actual real life data, the results can be invalid. The accuracy of the data has already been addressed.

Data Manipulation. As a result of the data format, the first effort of the study was to gather the more detailed

four digit FSC and SEC codes into the aggregated single digit categories. This was accomplished by hand conversion. There were 2849 data points altogether. Due to its volume, the actual data will not be included in this report.

The raw data was loaded into QUATTRO (software by Borland) by hand. It was then transferred to STATISTIX (software by NH Analytical Software) and used to gather some descriptive statistics on the data. They include the mean, standard deviation, number of data points, the median, and the minimum and maximum values for each treatment. The raw data was then uploaded to the AFIT VAX computer so the ANOVA tests could be accomplished using the SAS statistical program. The raw data was then organized into a QUATTRO spreadsheet in order to accomplish a Tukey pairwise comparison of means.

Statistical Analysis

This study used descriptive statistics to answer the first research question and conducted two-factor tests to answer the second research question. First, the aptness of the data for the models used was analyzed. Descriptive statistics and 95 percent confidence intervals were used to determine whether the means of each treatment were equal to .05, the SDB goal. To accomplish the two-factor testing, the study used ANOVA testing methods and pairwise comparison of means procedures. The remainder of this chapter

discusses the theory behind this analysis.

Aptness Analysis. Before performing any statistical tests, the study first analyzed the aptness of the data to be used in the parametric models which performed the statistical analysis. If the data is not apt for the models used, the results of the analysis will be unsound and suspect. The aptness analysis was accomplished by attempting to validate the assumptions of the data. These assumptions are:

1. The treatment data are normally distributed.
2. The treatment data have equal variances.
3. The treatment data are random and independent.

Since the data is a census, the third assumption is not necessary. However, the first two assumptions need to be tested.

This was done by looking at the residuals of the treatment data and performing Wilk-Shapiro tests on the data. The residual plots are defined as:

$$e_{ij} = Y_{ij} - Yhat_{ij} = Y_{ij} - Ybar_{i}.$$

The residual plots were determined using SAS. By testing for (1) nonconstancy of error variance, (2) outlier data, (3) omission of important independent variables, and (4) nonnormality of error terms one can check for the accuracy of these assumptions.

In order to check for nonconstancy of error, the residual plots should show about the same extent of scatter of the residuals around 0 for each factor level. The residuals for the data from this study did not show the same extent of scatter. Therefore, nonconstancy of error is an invalid assumption. For outliers, one needs to see if there are outlier observations and then accept, correct, or reject the data point if deemed necessary. Based on the plots, there are a couple of outlier data points. These were the same points that were greater than 1 and less than 0 during the descriptive statistics. These points were kept in the analysis because they could not be considered incorrect data. If there appears to be some factor which when examined leads the analyzer to believe he/she may separate the residual plots into distinctive groups, a more detailed multifactor analysis may be in order. This does not invalidate the original model, however, it shows more analysis should be accomplished. The residual plots did not indicate any patterns suggesting a variable should be added. To check nonnormality of the error terms, a histogram of the residuals was checked to see if they followed a normal distribution. The histograms indicated the data was extremely nonnormal.

In addition Wilk-Shapiro tests with rankit plots were conducted to determine normalness of the data using STATISTIX. The results are shown in Appendix A. If the

data was normally distributed, the data points on the rankit plot would be linear and about at a forty five degree slope from the origin and the Wilk-Shapiro test should result in a number between .9 and 1. Based on the results of these tests, none of the data sets could be assumed normal or even approximated as normal.

These results indicate the data did not satisfy the conditions for using parametric models and perhaps some nonparametric tests which can overcome the problems of nonnormal data should have been used.

The nonparametric tests generally use a ranking procedure to alter the data so it is usable by some statistical model. However, one drawback of this procedure is that if the analysis shows the treatments result in different means then the cause of the difference cannot be determined. Some authors have addressed this shortcoming. According to Jerome Myers, in his book Fundamentals of Experimental Design, nonparametric tests were not appropriate. He states:

> The use of nonparametric statistics . . . are also sensitive to differences in other parameters besides the mean and are not necessarily more powerful than the F test when the assumptions of that test are violated. The main reason for my restraint in using nonparametric statistics is simply that they are not versatile enough, that researchers who use the nonparametric approach are limited in the designs they can use and what they can ask of their data (19:75).

The choice the study was left with was to use the original models with the understanding that the normality assumption

has not been met. One must understand the results may or may not be valid based on this inability to meet the assumption of normality. However, until a statistical process is found that will accomplish the objectives of the study, the models used are the best statistical models available.

Research Question # 1. Using STATISTIX, confidence intervals were generated for each treatment to determine whether they did not meet, met, or exceeded the .05 level goal. The test used an α of .05 (95 percent confidence level). The confidence interval analysis is basically a hypothesis test with the following hypotheses:

H_0: The treatment mean equals .05.
H_a: the treatment mean is not equal to .05.

If the confidence interval contains .05, the mean equals .05 with a 95 percent level of confidence. The confidence intervals are based on the treatment means and standard deviations combined with the appropriate T value (a two-tailed T test). The results of this test are discussed in the next chapter.

Research Question # 2. The second research question was answered using a two-factor analysis. There are several advantages of performing two-factor analyses instead of single factor analyses. They are more efficient studies since two factors can be compared in the same test, more

information is gathered during the test, and the validity of the study can be increased by considering interaction between the two factors. The additional information regards interaction between the treatments and factor levels and cross treatment of the same.

This analysis consisted of three parts: (1) to perform a factor effects analysis to determine if there is interaction; (2) to transform the data, if necessary and if possible, to negate the interaction effects; and (3) to answer the second research question using a pairwise comparison of means. The strategy for conducting this analysis is depicted in Figure 4.

Factor Effects Analysis. The first step of two-factor analysis was to determine if interaction between the two factors was present. Interaction is important because it masks the main effects of the two factors. If no interaction is present, the factors can be described separately by analyzing the main effects (20:672). There are many ways to determine whether or not there is interaction:

1. If $\mu_{ij} = \mu.. + \alpha_i + \beta_j$ there is no interaction.

2. If the difference between the mean responses for any two levels of factor B is the same for all levels of factor A there is no interaction.

3. If the difference between the mean responses for any two levels of factor A is the same for all levels of factor B there is no interaction.

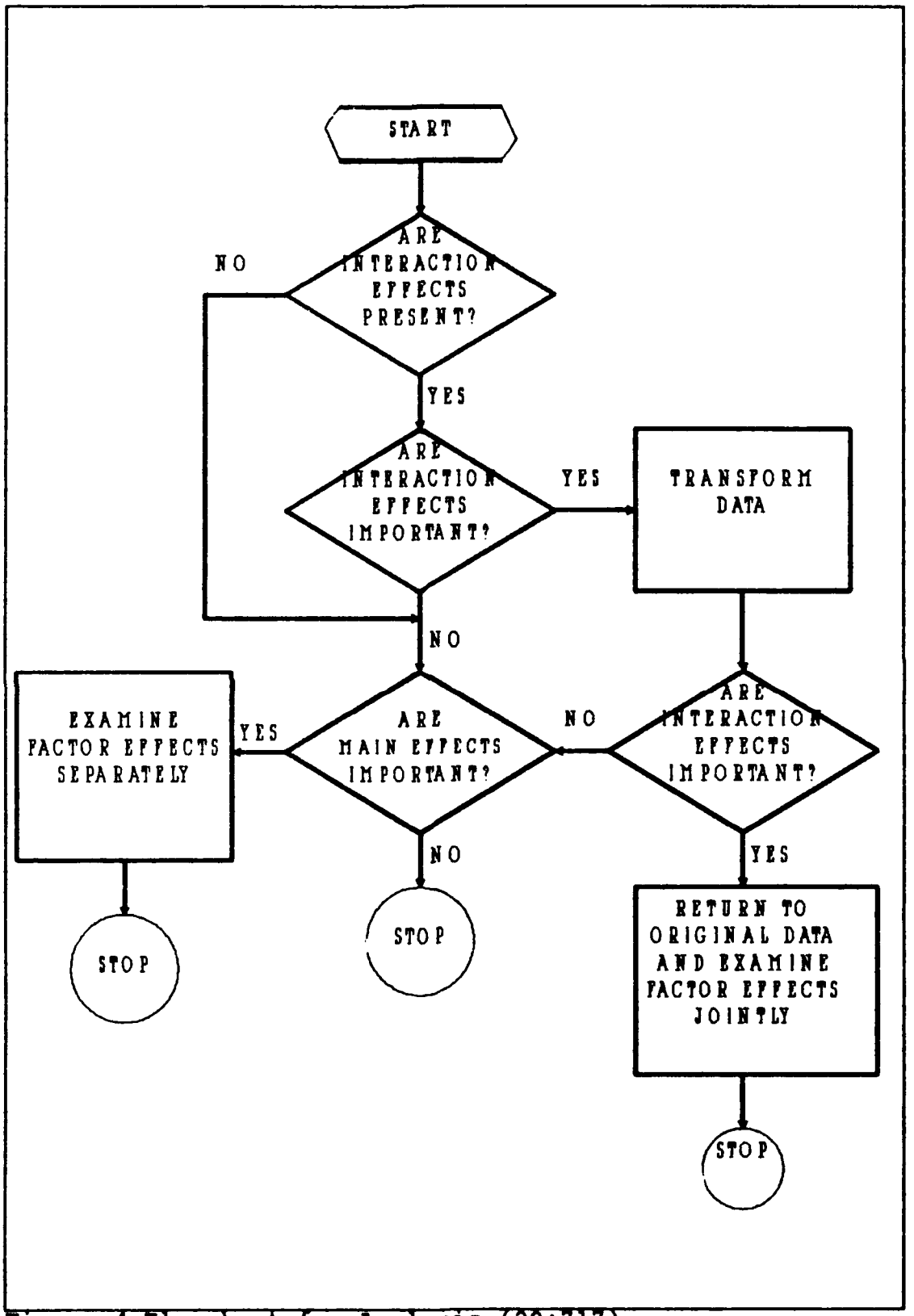


Figure 4 Flowchart for Analysis (20:717)

4. If the curves of the mean responses for the different levels of a factor are all parallel there is no interaction.

If there is interaction, there are two different classifications. Important interactions imply one cannot discuss or conclude the effects of each factor separately in terms of the factor level means. In contrast, unimportant interaction implies the interaction effects are small and the analysis can be the same as with no interaction at all (20:679). This distinction is subjective, however, and is left to the discretion of the analyzer.

To test for interaction, the study used a fixed-effect model because the factor levels were chosen for their intrinsic interest and they were not considered a sample from a larger population (20:523). One complication arose because the treatments had different sample sizes. The unequal sample sizes cause (1) the least squares equations normally used for ANOVA to be complicated and (2) the factor effect component sum of squares to no longer be orthogonal which leads to an inability to sum to SSTR (Sum of Squares of TReatments). As a result, a general ANOVA was performed with the General Linear Model (GLM) which allowed for correct analysis even with unequal sample sizes.

The GLM has several elements:

A. Treatment Mean

$$\mu_{ij}$$

B. Factor Level Means

$$\mu_{\cdot j} = \frac{\sum_{i=1}^{a} \mu_{ij}}{a} \qquad \text{where a = \# of j treatments}$$

$$\mu_{i \cdot} = \frac{\sum_{j=1}^{b} \mu_{ij}}{b} \qquad \text{where b = \# of j treatments}$$

C. Overall Mean =

$$\mu_{\cdot\cdot} = \frac{\sum_{i} \sum_{j} \mu_{ij}}{ab}$$

D. Specific Effects

$$\beta_{j(i)} = \mu_{ij} - \mu_{i \cdot}$$

$$\alpha_{i(j)} = \mu_{ij} - \mu_{\cdot j}$$

E. Main Effects

$$\beta_j = \frac{\sum_{i} \beta_{j(i)}}{a} = \mu_{\cdot j} - \mu_{\cdot\cdot} + \sum_{j} \beta_j = 0$$

$$\alpha_i = \frac{\sum_{j} \alpha_{i(j)}}{b} = \mu_{i \cdot} - \mu_{\cdot\cdot} + \sum_{i} \alpha_i = 0$$

The GLM now needs to be fitted for each test of factor interactions (20:747).

The fitted model is defined as:

$$Y_{ijk} = \mu.. + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \epsilon_{ijk}$$

where: $\mu..$ is a constant

α_i is a constant subject to $\Sigma\alpha_i = 0$

β_j is a constant subject to $\Sigma\beta_j = 0$

$(\alpha\beta)_{ij}$ are constants subject to

$$\sum_i (\alpha\beta)_{ij} = 0 \text{ and } \sum_j (\alpha\beta)_{ij} = 0$$

ϵ_{ijk} are independent and $N(0,\sigma^2)$

and $i = 1...a$, $j = 1...b$, $k = 1...n$

In this study a equaled 4 and b equaled 5 since this is how many factor levels there are for each. The degrees of freedom for the a factor are:

$$a - 1 = 4 - 1 = 3$$

and for the b factor are:

$$b - 1 = 5 - 1 = 4.$$

The parameters are:

$$\mu..$$

$$\alpha_i = \mu_{i\cdot} - \mu..$$

$$\beta_j = \mu_{\cdot j} - \mu..$$

$$(\alpha\beta)_{ij} = \mu_{ij} - \mu_{i\cdot} - \mu_{j\cdot} + \mu..$$

When testing for interaction effects with the regression model the following hypothesis test was accomplished:

H_0: all $(\alpha\beta)_{ij} = 0$

H_a: not all $(\alpha\beta)_{ij} = 0$

In order to accomplish this, an F test was done where

$$F^* = \frac{SSE(R) - SSE(F)}{df_R - df_F} \Big/ \frac{SSE(F)}{df_F}$$

If α is set at .05, $F(.95, df_R - df_F, df_F) = X$ and if $F^* < X$, there is no interaction.

To accomplish this, data matrices were designed in order for the SAS statistical package to analyze the data. It consisted of an x matrix and a y matrix. Basically, the x matrix was designed so the elements of the data set (factor levels and treatments) could be analyzed using matrix algebra. The actual data was designed as a y matrix. Due to the size of the matrices they were not included in the study. The x matrix was set equal to the y matrix so the treatments and factor levels become the dependent variables and the data becomes the independent variable.

The hypothesis to test for interaction was:

H_0: All the interaction terms are equal.
H_a: At least one treatment mean is different.

The test showed interaction is present. This is discussed in more detail in the Findings and Analysis chapter.

In addition to this GLM test, an analysis of interaction was accomplished graphically. The lines resulting from plotting the factor levels of interest with the values of the alternate factor levels serving as data points were not

parallel, indicating interaction. See the next chapter for the graphed interaction plots and further analysis.

Transforming Data. The next step in the analysis would be to perform some type of transformation on the data to attempt to correct the above shortcomings. However, based on the specific nature of this data, transformation was infeasible. No simple form of transformation could be accomplished which will allow main factors to be analyzed.

Since there was interaction present and it could not be transformed, the study could not determine main factor effects (whether there is a significant difference in means between the main factors; i.e., FSC factor levels and SEC factor levels). The only possibility for further analysis was to test for simple main effects using a pairwise comparison of means within each factor level.

Pairwise Comparison of Means. The pairwise comparison of means was accomplished through a Tukey analysis. The Tukey method of analysis uses the studentized range distribution and does pairwise combination comparisons of the means to determine if there is a significant difference between any of the factor means. This allows the researcher the opportunity to see which of the treatments account for the difference in means. The analysis was accomplished using QUATTRO and the formulas for a Tukey pairwise comparison of means as given in Neter, Wasserman and Kutner (1985). The QUATTRO output is given in Appendix

B. The objective was to determine those treatments which differed significantly from the others based on their means, their MSE (mean standard error) and their standard deviations. A difference between the treatments of interest is determined and then a confidence interval was calculated based on the aforementioned parameters. If the resulting confidence interval contains zero, then the two treatments are not significantly different. However, if they do not contain zero, then the treatments do differ significantly. This may lead to some conclusions about contracting categories factors which make it easier or more difficult to meet the goal. The results of the analysis are discussed in the next chapter.

Conclusion

This chapter discussed the methodology used to perform the tests to answer the research questions. The collected data was found to not be apt for the parametric models used, however, no better models exist which can perform the tests so the parametric models will be used. However, this may cause the results of the tests to be suspect. The statistical models were used to accomplish a confidence interval analysis which attempted to answer the first research question and ANOVA procedures were used to answer the second research question. The next chapter discusses the results of these tests.

IV. Findings and Analysis

Introduction

The objective of this research was to determine whether the type of contracting effort and equipment/industry classification impacted the ability of AF organizations to meet the five percent Small and Disadvantaged Business (SDB) goal. This chapter focuses on the results of the data collection and statistical analysis as they pertain to the following research questions:

1. Does the percentage of contract dollars going to SDBs meet the five percent goal, given the type of contracting effort and the specific industry or product classification?

2. Does the percentage of contract dollars going to SDBs significantly vary between category of contracting effort and equipment/industry classification?

This chapter presents the findings of the research based on Air Force Systems Command (AFSC) contracts covering the years 1987-1989. Specifically, it contains some general findings, the findings of the confidence interval generation conducted to answer the first research question, and the Analysis of Variance (ANOVA) analysis which includes a pairwise comparison of means to answer the second research question.

General Findings

A summary of the data is presented in Figure 5. It provides the mean proportion of dollars awarded to SDB firms, the standard deviation, and the number of sub-classifications which served as observational elements for each combination of contracting effort and equipment/industry classification. The "=", "<", and ">" symbols indicate whether the mean proportions are statistically equal to, less than, or greater than the five percent SDB goal established by Congress. The following abbreviations are used in the figure and throughout the

MEAN * / ST. DEV. / COUNT	AIR&ENG	MSL&RKT	WPN&AMMO	ELEC	OTHER	OVERALL
RDT&E	.0672 = .2445 113	.0422 = .1874 171	0 < 0 4	.0384 = .1772 97	.0974 > .2453 507	.0491 -- 892
SVCS& CONST	.3261 > .4688 46	.1509 > .3580 53	0 < 0 2	.1884 > .3879 47	.1749 > .3460 765	.1681 -- 913
SUP& EQUIP	.0702 = .2511 186	.0442 = .1992 101	0 < 0 4	0 < 0 66	.1407 > .3274 675	.0510 -- 1032
UNCODED	0 < .0492 1	0 < .0252 2	0 < 0 1	0 < .0267 2	.0901 = .2014 6	.0180 -- 12
OVERALL	.1159 -- 346	.0593 -- 327	0 -- 11	.0567 -- 212	.1258 -- 1953	.0715 -- 2849

* - Sign represents CI position relative to 5% goal

Figure 5 Summarized Data Matrix

remainder of the study:

Air	Aircraft
Eng	Aircraft Engines
Msl	Missiles
Rkt	Rockets
Wpn	Weapons
Ammo	Ammunition
Elec	Electronics
RDT&E	Research, Development, Test, and Evaluation
Sup	Supplies
Equip	Equipment
Svcs	Services
Const	Construction

The first general observation is the wide range of means and standard deviations. Several cells, most notably the ones associated with Weapons and Ammunition contracts as well as Uncoded Federal Supply Classifications, have means of zero and small standard deviations. Such statistics suggest there are pockets of contracting efforts which are clearly having difficulties meeting the five percent goal. Similarly, there are some cells with quite large means, ranging from nearly 10 percent to over 30 percent of contract dollars awarded to small and disadvantaged firms. However, these are marked by quite large standard deviations, suggesting the data is very dispersed. In part this was due to the fact that many sub-elements would tend to be all or nothing in terms of SDB awards. These areas apparantly have pockets of great opportunity for conducting business with SDB firms. Thus, the data suggest that generally the opportunity or ability to contract with SDBs

is not consistent across categories of contracting efforts or types of industry and equipment involved. More specific trends will be discussed later. The wide range of variance also indicates that the assumption of homogeneity of variance required by parametric statistical techniques has been violated. This was addressed in some detail in the methodology chapter. This limits the validity and certainty with which statistical inferences can be made. This should be kept in mind when considering the results of the statistical tests.

The large variation in observations for the cells are due to the number of sub-categories falling into each pair of categories (type of contracting category and type of equipment/industry involved). Of special interest is the large number falling into the "Other" category. In fact, over 68 percent of the total datapoints were in this area. This was a result of either not coding in the SEC classification or coding in "000". This classification also included vehicles and ships, but there were very few datapoints from these classifications (three). The means for this area were generally quite high, suggesting fairly good opportunity for SDB contracting. Unfortunately, the lack of visibility in this area does not permit detailed analysis.

There were some FSC datapoints which were uncoded. The unfortunate result of these uncoded FSC and SEC entries and

miscoded SEC entries is that instead of this data falling into its appropriate category, it fell into a catch-all category. With no background information on the specific contracts, no conclusions can be reached on the data from these uncoded categories, other than there appears to be varying levels of SDB contracting.

One problem encountered during the statistical analysis was that the assumption that the treatment data sets had normal distributions was not met. This assumption was investigated through a residual analysis and Wilk-Shapiro rankit plots. The result of this investigation showed the data sets were far from normal. This would normally force nonparametric test methods. However, it was determined the originally intended model would work as well as a nonparametric test because of the ratio data involved. The drawback is that the results of the analysis may be suspect because of this invalidated assumption. Until a better model is developed, this is the best analysis that can be done.

Research Question # 1

The first research question addressed whether or not the ability to meet the five percent goal was dependent on the type of contracting effort and the industry/equipment category involved. In order to answer this, 95 percent confidence intervals were established for each cell of

Figure 5. This confidence interval suggests that if the data were normally distributed, and repeated random samplings were taken, the true proportion of contracts awarded to SDB firms would be captured 95 percent of the time. In this case, if the confidence interval included .05, the cell was judged not to be statistically different and thus equal to the fiver percent goal. These cells are annotated with an "=" symbol. If the confidence interval was lower than .05, it was judged to be lower than the goal (indicated by "<" in the figure). Similarly, intervals above .05 were designated as greater than the five percent goal (indicated by ">").

The treatments which did not meet the goal were clustered mainly in the Weapon and Ammunition equipment/industry classification and the Uncoded contracting category. Given the means and standard deviations of zero, it appears that contracting in the Weapon and Ammunition classifications has a difficult time meeting the five percent goal, at least in the AFSC environment, which could be contracting for research and development, production, and deployment of new systems. That may or may not be true when contracting for spares and other support. It is difficult to interpret the lack of SDB contracting for the uncoded FSCs.

Electronic supplies and equipment also had a mean and standard deviation of zero. Thus, systems contracting in

this area appears to be restricted. It may be that there are very limited numbers of SDBs that have the technical capability to make high technology electronic components, even though there appear to be SDB firms capable of performing RDT&E efforts. It is possible that there might be SDBs capable of producing replenishment spares. Most of the Supply and Equipment contracting for spares performed in the AF is performed by the Air Force Logistics Command (AFLC). For this reason, data obtained from the AFLC may indicate a greater opportunity for contracts in this area and higher number of SDB business.

The treatments which met the goal were concentrated in the RDT&E and the Supply and Equipment contracting categories. They contained five of the six treatments which met the goal. The Aircraft and Aircraft Engine, Missile and Rocket, and Electronic classifications in the RDT&E category had a substantial number of data points and met the goal. This indicates the RDT&E and the Supply and Equipment categories not only have opportunities to use SDB businesses, but have a sufficient emphasis and number of SDB contractors to meet the goal. The "Other" classification for the RDT&E efforts supports this conjecture since it shows the SDB percentage of contracting dollars exceeds the goal.

The Supply and Equipment category met the goal in the Aircraft and Aircraft Engine classification and the Missile

and Rocket classification. This indicates there is ample opportunity for contracts in these areas and there is enough emphasis and are enough SDB contractors to meet the goal. The "Other" classification within this category supports this conjecture since it exceeds the goal.

The classifications which had a notable number of treatments which met the goal were the Aircraft and Aircraft Engine classification and the Missile and Rocket classification. Except for the Uncoded categories, all the treatments met or exceeded the goal. The categories in these classifications which had a substantial number of datapoints (RDT&E and Supply and Equipment) met the goal but the category which had significantly fewer datapoints (Services and Construction) exceeded the goal. This indicates that within the RDT&E and the Supply and Equipment contracting efforts there was a wide range of sub-classifications available for SDB contracting yet they could only meet the goal whereas in the Services and Construction effort there were fewer sub-classifications to meet the goal in yet the data exceeded it. It appears that systems contracting efforts for the Aircraft and Aircraft Engine products and in the Missile and Rocket industries have considerable services and construction contracting opportunities and that a relatively high proportion of these can go to SDBs.

The treatments which exceeded the goal were clustered in

the Services and Construction contracting category and the "Other" industry or product classification. All of the "Other" treatments except the treatment from the Uncoded category and all the Service and Construction treatments except the treatment from the Weapons and Ammunition classification exceeded the goal. This indicates there is sufficient opportunity in the Services and Construction contracting efforts to hire SDBs and ample SDBs to perform the contracts. The "Other" category's ability to exceed the goal indicates that there is enough interest in SDBs and enough SDBs performing to allow these "hard to code" or uncoded industry efforts to exceed the goals. These areas, if more visible, might offer some suggestions to increase opportunities of SDB contracting.

This section showed that some treatments were below the goal, some met the goal, and some exceeded the goal. Moreover, it suggests a pattern of opportunity may exist. the second research question examines whether any general patterns exist in terms of classification of contracting efforts and the type of equipment/industry involved.

Research Question # 2

To answer the second research question an ANOVA was performed on the data. The original goal was to determine whether or not there is a significant difference in means between the main factors (i.e., FSC factor levels and SEC

factor levels). However, complications arose during the process. The ANOVA process has three basic steps, (1) determine if there is interaction between the factors of interest, (2) if there is interaction, transform the data so the interaction is not a factor, and (3) perform the analysis to answer the research question.

The first step was accomplished using the General Linear Model (GLM) to perform an F test. The objective of the F test procedure is to answer the following hypothesis:

H_0: All the interaction terms are equal to 0.
H_a: At least one interaction term is not equal to 0.

This was accomplished using SAS statistical software. The results are shown in Figure 6.

Dependent Variable: Y

Test:	Numerator:	0.2010	DF:	11	F value:	2.2721
	Denominator:	0.088482	DF:	2828	Prob>F:	0.0094

Figure 6 SAS Hypothesis Testing Results

Since the p value (Prob>F or .0094) is less than the α value for the desired confidence level (α is equal to .05 for the desired confidence level of 95 percent), the test shows there is interaction.

Another method used to determine whether interaction is present is to plot the factor levels of interest with the values of the alternate factor levels serving as datapoints in that factor level. If there is no interaction the lines

should be parallel. The results of this method are presented in Figures 7 and 8.

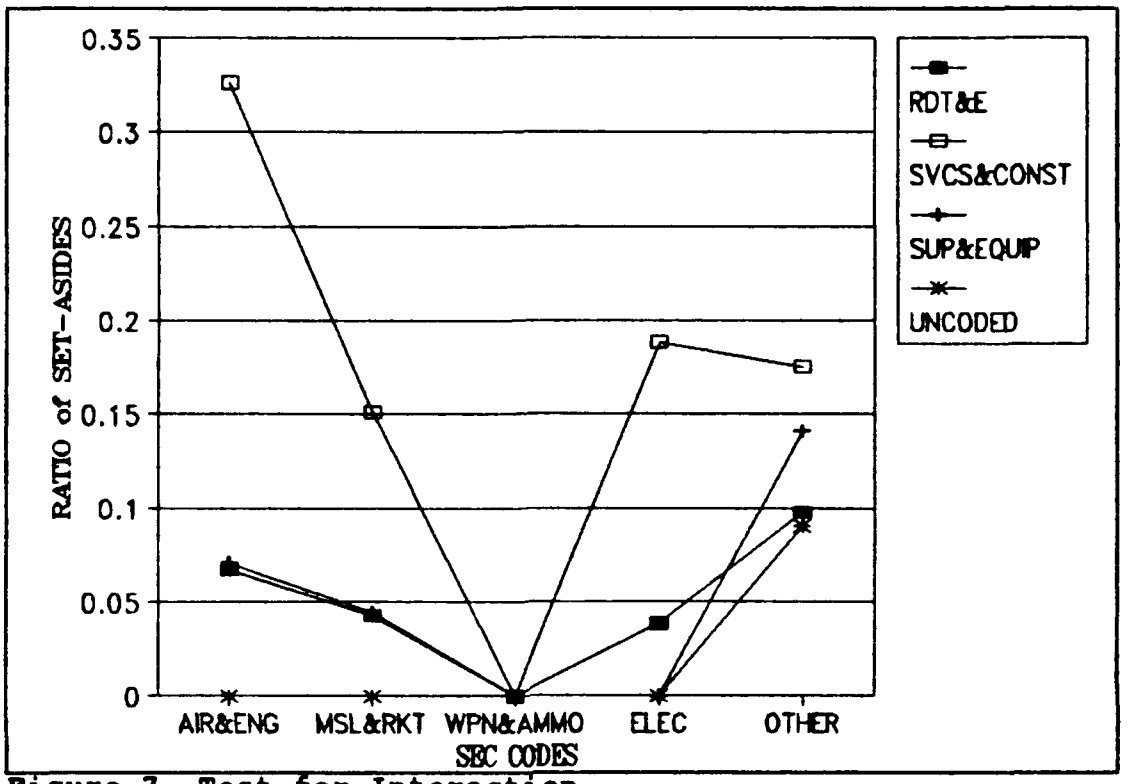


Figure 7 Test for Interaction

The two figures not only showed interaction, but significant interaction. However, in addition to showing interaction, the figures highlight some general patterns. In Figure 7 the percentage of SDB efforts in the Services and Construction category of contracting is higher than all the other areas except for within the Weapons and Ammunition industry classification. In Figure 8, the lines all follow the same trend only with different magnitudes. Within the RDT&E category, all the equipment/industry classifications are clustered around .05. All the classifications then

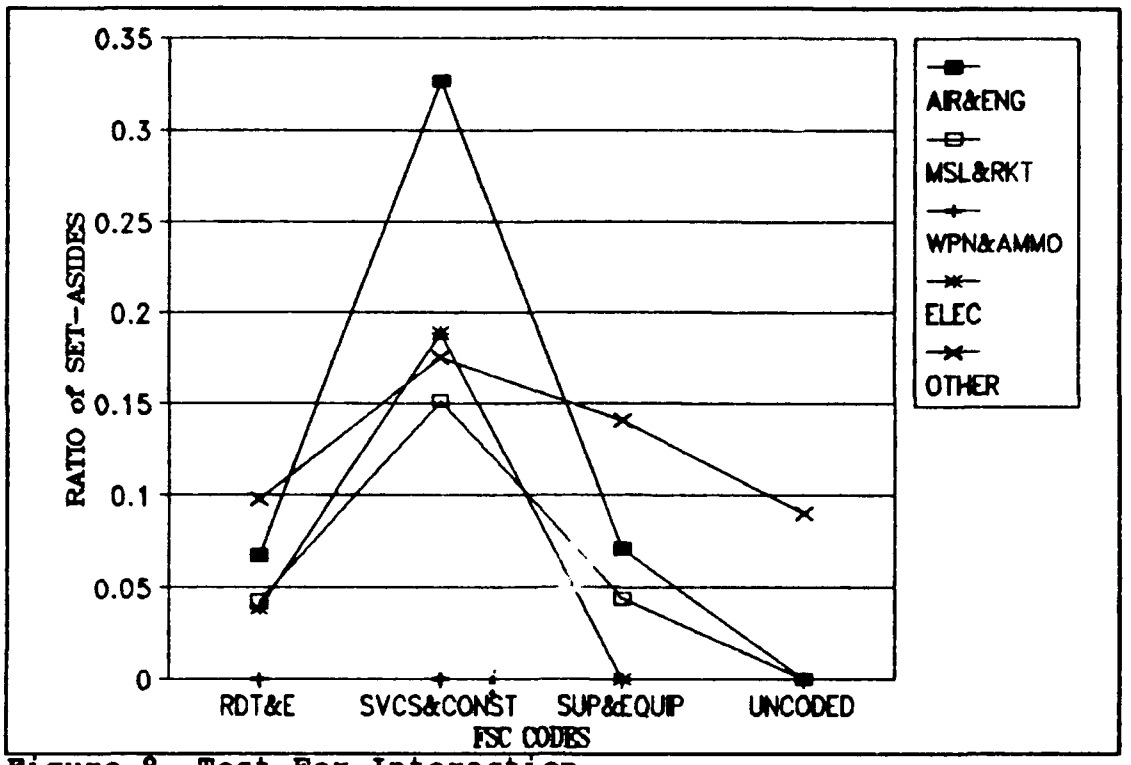


Figure 8 Test For Interaction

increase for the Services and Construction area, and decrease for the Supply and Equipment category. The classifications then decrease again for the Uncoded category. In general, the Services and Construction category has a higher percentage than the other classifications. These results correlate with those discussed in the previous section on confidence intervals.

The previous figures showed significant interaction. In fact, the interaction is so significant that no transformation will allow the main factors to be compared. Therefore the analysis of main effects will not be accomplished. The analysis to determine whether there is a significant difference between the means will be confined to

analyzing the treatments within a factor level. This allows the analyzer to focus on any one particular level rather than a general analysis across all treatments and factor levels. The next step is to perform a pairwise comparison of means to determine whether there are significant differences in the treatment means within a given category or classification and which are significantly different. This was accomplished with a Tukey pairwise comparison of means.

The Tukey analysis generates confidence intervals for each pair of treatments under investigation and then determines whether the treatment means can be considered the same within a specified confidence level (95 percent in this study). It is a relatively conservative approach since it uses the studentized T distribution in its analysis. The Tukey analysis in this study was performed with QUATTRO software and the formula for Tukey generation for variables with unequal sample sizes from Neter, Wasserman ,and Kutner (1985).

The standard way to show the results of a Tukey analysis is to underline those treatments which do not differ significantly. In some cases one or more treatments will be underlined more than once. In this case, the ones underlined with the same line are not significantly different but those treatments not underlined with the same line are significantly different. A summary of the output

for the SEC code as the major factor follows.

SEC Codes as Major Factors. The results of the Tukey Analysis with the equipment/industry classifications as the major factors are shown in Figure 9.

The Services and Construction contracting category is significantly different from the RDT&E and Supplies and Equipment contracting categories in all the

Aircraft and Engine Code

SVCS&CONST RDT&E SUP&EQUIP UNCODED

Missile and Rocket Code

SVCS&CONST UNCODED RDT&E SUP&EQUIP

Weapon and Ammunition Code

RDT&E SVCS&CONST SUP&EQUIP UNCODED

Electronics Code

SVCS&CONST UNCODED RDT&E SUP&EQUIP

Other Code (includes uncoded)

RDT&E UNCODED SUP&EQUIP SVCS&CONST

Figure 9 Tukey Analysis for SEC Codes

equipment/industry classifications except for within the Weapons and Ammunition classification. It is not significantly different than any other contracting category within the Weapons and Ammunition classification. This information, combined with the results of the confidence interval analysis, indicates that the services and construction category has a significantly higher amount of dollars (in terms of a percentage of total dollars) going to SDBs. The AFSC might perform most of the "operational" or base level contracting at it's own bases and product divisions. This operational contracting would likely include services and construction at these AFSC bases and product divisions. This could explain the higher means for this type of contracting.

The RDT&E and the Supply and Equipment categories only differ significantly within the "Other" equipment/industry classification. This indicates the amount of dollars going to SDBs (once again in terms of percentage of total dollars) is not significantly different in these classifications. The AFSC is most likely to perform supply and equipment contracting simultaneously with its RDT&E contracting because it is developing and producing these products to fit its developing major systems.

Within the Missile and Rocket industry classification, the Services and Construction category differs significantly from the RDT&E contracting category and the Supplies and

Equipment contracting category but does not significantly differ from the uncoded entries. This could be a result of the large variance associated with the uncoded data points. With a large variance, it is more likely to be equitable with the other treatments. The significant difference between the Services & Construction category and the RDT&E and Supplies & Equipment categories shows that in the Missile and Rocket industry classification most of the SDB contracting is accomplished in the area of services and construction. This indicates a greater opportunity for an SDB to contract with the AF in the Services and Construction classification if the SDB is operating in the Electronics or Missile and Rocket categories.

Within the Weapons and Ammunition classification area, all the areas studied have approximately the same SDB efforts. The zero means and the small standard deviations for all the contracting categories within this classification indicate little opportunity for SDB firms to perform work in the systems area. Perhaps there are very few or no SDBs which can operate in this area or perhaps it is a result of the majority of the DODs efforts in this area being accomplished at government facilities by either government personnel or employees of large defense contractors.

Within the Electronics contracting efforts, none of the areas analyzed differ from the uncoded area, but the RDT&E

category and the Supply & Equipment category differ significantly from the Services & Construction category. This is similar to the Missile and Rocket categories's results and could be for the same reasons.

Within the "Other" industry classification, RDT&E, Supplies and Equipment, and Services and Construction categories differ significantly from each other. Only the uncoded category does not differ significantly from any of the others. Since this area has the most data of any area, the results may be the most accurate. However, they cannot be associated with any specific type of Supply & Equipment area of contracting.

The Tukey analysis with the FSC code as the major sort factor follows.

FSC code as Major Factor. The results of the Tukey Analysis with the contracting categories as the major factors are shown in Figure 10.

This measure of analysis is useful because it sorts by type of industry. One can determine which industry type (as determined by SEC code) has the greatest percentage of dollars going to SDBs in each contracting category.

Within the RDT&E contracting efforts, the "Other" category differs significantly from Missiles & Rockets and Electronics. However, the Missiles and Rockets, Electronics, Aircraft and Engines, and Weapons and Ammunition classifications do not significantly differ. As

mentioned earlier, the "Other" classification does not give much meaningful information. Therefore, the data do not suggest the four classifications are different in their ability to contract with SDBs. This indicates that in terms of percentage of dollars going to SDBs, in the RDT&E contracting category, all the product divisions are clustered closely (compared to the other contracting

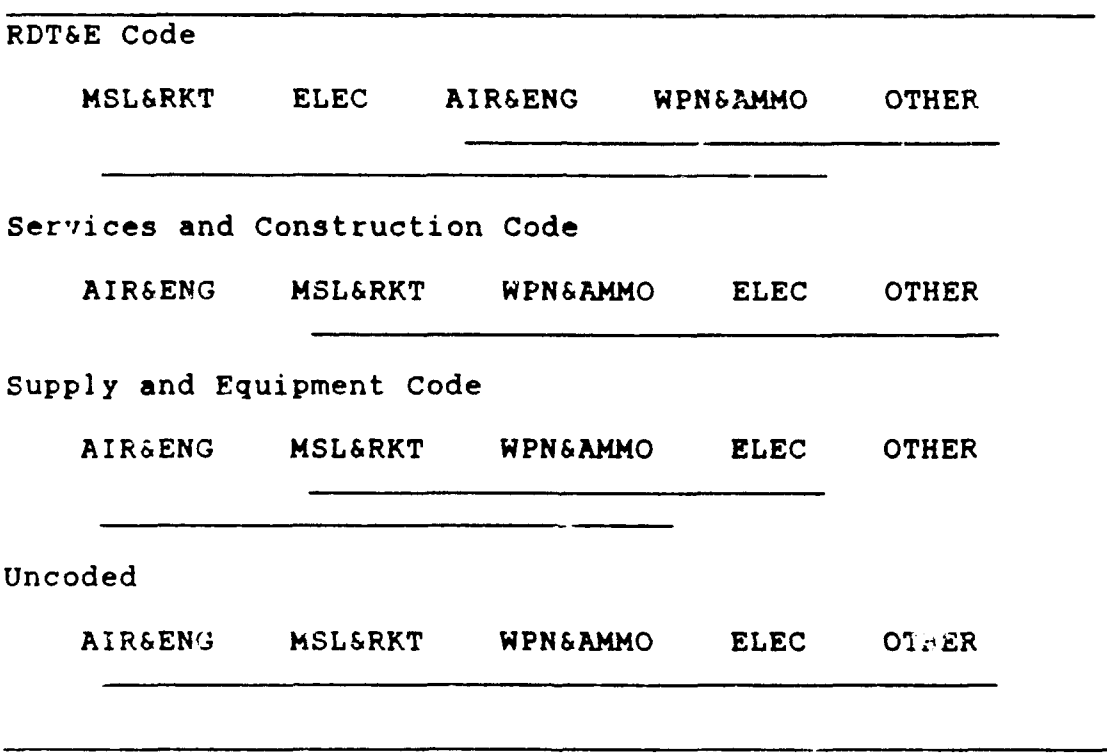


Figure 10 Tukey Analysis for FSC Codes

categories) around the five percent goal.

Within the Services and Construction contracting efforts, the Aircraft and Engine SDB percentages differs significantly than the other areas. Therefore, service and construction contractors tend to be SDBs more in the category of Aircraft and Aircraft Engines than in the other

categories studied. Aircraft and aircraft engine development and production may require more accompanying service and/or construction efforts than other types of AFSC efforts.

Within the Supply and Equipment contracting category, the "Other" classification differs significantly from all the other classifications and Aircraft & Engine differs significantly from Electronics. The "Other" category tends to have higher percentages of SDB contracting efforts while Aircraft & Engine areas tend to contract with SDBs more than Electronic areas. Once again, the "Other" category does not give much meaningful information. However, there is a significant difference between the dollar percentages going to SDBs between the Aircraft and Aircraft Engine and the Electronics contracting categories. This indicates that within the Supply and Equipment industry, there is more SDB contracting in the Aircraft and Aircraft Engine category than in the Electronics category. The reason for this was addressed earlier when it was mentioned that in the aircraft and aircraft engine efforts, supplies and equipment to support those systems may be compatible with SDB qualifications whereas in the electronics efforts the supplies and equipment may not be suitable for SDB efforts.

Within the uncoded area of contracting efforts, none of the areas differ significantly. Since all the means of the coded classifications were all equal, the differences

between them will not be significant. And, since the standard deviation for the "Other" category was large with a mean near the others, this category will not be significantly different, either.

Conclusion

The results of the statistical analysis show that there is some disparity in AF organization's abilities to meet the five percent goal. These abilities depend on both the contracting category and equipment/industry classification the organization is operating in. It also shows that within the contracting categories and equipment classifications, some combinations are significantly different than others in their SDB contracting efforts. The next section will address how these results can be generalized to assess the ability of AFSC organizations to meet the goal.

V. Conclusions and Recommendations

Introduction

This study assessed the ability of Air Force Systems Command (AFSC) organizations to meet a Congressionally mandated five percent Small and Disadvantaged Business (SDB) contracting goal. It achieved this objective by answering the following two research questions:

1. Does the percentage of contract dollars going to SDBs meet the five percent goal, given the type of contracting effort and the specific industry or product classification?

2. Does the percentage of contract dollars going to SDBs significantly vary between category of contracting effort and equipment/industry classification?

This chapter briefly reviews the methodology used to answer these research questions, presents the conclusions of the research, discusses the implications of the conclusions, and provides some recommendations for further research.

Methodology Summarization

The study answered the research questions by gathering data and performing a statistical analysis on it. Data on contract awards to SDB firms was gathered from the Air Force Systems Command (AFSC) contract database for the years 1987-1989. It was organized by factors based on the Federal Supply Classification (FSC) code which indicates the type of

contracting effort involved and the Supply and Equipment (SEC) code, which identifies the nature of the equipment/industry involved. The contracting categories studied were (1) Research, Development, Test, and Engineering (RDT&E), (2) Services and Construction, (3) Supplies and Equipment, and (4) Uncoded. Aircraft and Aircraft Engines, Missiles and Rockets, Weapons and Ammunition, Electronics, and Other (which included vehicles and ships) classifications were chosen to represent the industry involved or product produced. Since the data was gathered from only the AFSC, the conclusions drawn only pertain to AFSC and not necessarily to other AF, DOD, or Federal agencies. Generalizations might be possible to the degree that other DOD organizations undertake the same type of contracting actions with the same equipment/industrial classifications. However, future research will need to determine that for sure.

The statistical analysis consisted of a confidence interval analysis and two-factor Analysis of Variance (ANOVA) procedures. The 95 percent confidence intervals were generated to determine if the individual contracting sectors represented by combinations of FSC and SEC codes were successful in meeting the five percent SDB goal. The ANOVA procedure determined significant interaction between the main factor categories was present and therefore pairwise comparisons of means were conducted between

treatments within each factor level. Analysis of the dat. determined that the data violated underlying assumptions for the confidence interval analysis and the ANOVA. The data were not normally distributed, nor were they continuously distributed. There was also no homogeneity of variance. Thus, the reliability of the tests are uncertain. However, there is no better model at this time to perform the analysis. Thus, the statistical tests were used to gain whatever insight was possible into the research questions.

Research Question # 1

The confidence interval analysis suggested that in the systems contracting area, an AF organization's ability to meet the five percent goal which depends on the nature of the contracting effort and the type of equipment or industry involved. In general, the Weapon and Ammunition classification was the only factor level to fall short of meeting the goal. No type of contracting effort in this classification had contract awards to SDB firms. Contributing to this may be that many weapon and ammunition system development and production efforts are performed by large businesses using government facilities. The results infer there is currently little chance of contracting with an SDB in this area.

The uncoded contracting category also resulted in low levels of SDB contracting which did not meet the goal.

However, because it was uncoded inferences based on this information are extremely limited.

The "Other" equipment/industry classification had many datapoints (69 percent of the total datapoints) but the information gathered from this area is also limited. The contracting categories in this factor level (except uncoded) all exceeded the goal. This can lead to the conclusion there are opportunities in the AFSC to contract with SDBs but the specific classifications of these opportunities are unknown. To the degree that uncoded entries represent errors, (i.e., they should have been coded into one of the other classifications) the actual proportions of contracts going to SDBs for the other SEC areas may be understated. Otherwise, the miscellaneous categories falling into the "Other" area provide a great opportunity to contract with SDBs.

The Services and Construction category showed the most promise for contracting with SDBs. It had a large number of datapoints and its means (except for in the Weapons and Ammunition classification) were higher than the other contracting categories. This implies that not only are there many opportunities for contracting with SDBs in the Services and Construction area, but the ability of SDBs to receive the contracts is high. This category had many contracts where a large percentage of the contract went to SDBs. With the exception of the weapons and ammunition

classification, this area is ideal for SDB contracting. This suggests the five percent goal is too small in this area. Construction was one area Congress expected to be able to meet a forty percent goal if the field was expanded to include small businesses. The data suggest that this might be an attainable goal for aircraft related construction efforts.

In general, the other categories and classifications met or exceeded the SDB goal. The one exception was the Supply and Equipment category within the Electronics industry which averaged no SDB actions. There must be some unique characteristic about this category, at least for systems contracting, which does not allow it to cater to the SDBs. Perhaps there are too few SDB producers of highly technical electronic systems and parts typically used by the AF. In contrast, RDT&E contracting in the electronics area contracted with SDBs in nearly 18 percent of their efforts. Apparently, there is great opportunity to contract with SDBs in this area, perhaps due to a large percentage of the PhD's in this country being held by minority individual as suggested in the literature review.

The data suggests that when categorized by (1) Federal Supply Classification code and (2) Supply and Equipment codes, there are pockets of contracting where it is extremely difficult to meet the SDB goal. Similarly, there are pockets of contracting where the goal is quite

attainable. However, the analysis focused on each sector to meet the five percent SDB goal. The next research question looked for relationships between FSC and SEC classifications as they relate to SDB contracting.

Research Question # 2

The pairwise comparison of proportion of SDB contracts concluded there were significant differences in the ability of some contracting categories and equipment/industry classifications to meet the five percent goal. The most significant finding was that the Services and Construction contracting category as a whole was significantly higher than other contracting categories in all the industry classifications except the Weapons and Ammunition classification. The significant difference confirms the earlier suggestion that this category has a significantly higher percentage of the contract dollars going to SDBs than any other category of contracting. The Services and Construction could have a significantly higher number of SDBs available for contracting.

The RDT&E category and the Supply and Equipment category do not differ significantly except when the "Other" SEC classification is addressed. This implies AFSC may have roughly the same opportunity of meeting the SDB goal in these categories of contracting no matter what industry or product they are dealing with.

The percentage of contract dollars going to SDBs within the Services and Construction contracting category is significantly higher in the Aircraft and Aircraft Engine classification. It may be that contracting for the development and production of aircraft and production of aircraft systems provides for more construction and service contracting than does contracting for other systems. It is also likely there are more SDB contractors in the construction service area in general, and perhaps in the aerospace sector in specific.

Within the Supply and Equipment contracting category, the percentage of dollars going to SDBs is significantly higher in the Aircraft and Aircraft Engine industry than in the Electronics industry. Perhaps systems contracting for aircraft and aircraft engines within the Supply and Equipment category uses technology and skills that are more readily available to SDB firms than is the case for highly technical electronics equipment. Thus, differences here may be very industry specific.

These results show that in some of the areas studied, the differences between the treatments are statistically significant. The implications of these will be discussed next.

Implications for Managers

One may notice the equipment/industry classifications

correspond to the product divisions of AFSC. The Aircraft and Aircraft Engine contracting is performed primarily by the Aeronautical Systems Division (ASD), the Missile and Rocket contracting by the Space Systems Division (SSD) and the Ballistic Systems Missile Division (BSD), the Weapons and Ammunition contracting by the Munitions Systems Division (MSD) and the Electronics contracting by the Electronic Systems Division (ESD). Therefore conclusions drawn about the equipment/industry classifications may be appropriate for the respective AFSC divisions.

It appears as if the MSD had very few contracting opportunities with SDBs. However, the MSD contracts deal primarily with highly sophisticated munitions which take years to develop and produce. Many of these are produced by large contractors at government facilities and plants. These complicated systems leave little opportunity for SDBs to perform the prime contracts, but may leave considerable sub-contracting opportunities. It also might be that the greatest opportunity for SDB contracting in this area would be replenishment spares. In order to better analyze the Weapons and Ammunition classification, one should also study Air Force Logistics Command (AFLC), Army, and Navy contracts which probably have a much larger number of contracts in this area. In order to improve SDB participation, MSD would have to develop capable SDB sources that could help develop, produce, or test the type of weapon systems and AF munitions

it manages.

The ESD had better opportunities for SDB contracting in the RDT&E area than in the supplies and equipment area. This imlies that ESD should use a search strategy to find SDBs who can perform RDT&E efforts. However, However, in the supplies and equipment area, ESD should focus on developing sources, if possible, to increase the opportunities in this area.

The ASD had high opportunity for SDB contracting in all its areas. The reasons for this could be analyzed and the conclusions could be used to develop a strategy for increasing SDB contracting support other divisions to meet the SDB goal. The SSD and BSD could likewise develop a strategy for increasing SDB contracting in their areas.

The confidence interval analysis indicated that all the rest of the divisions in the AFSC met or exceeded the goal in the various categories except for within the Uncoded category and the Supply and Equipment category in the classification related to the ESD. It appears there is sufficient opportunity to contract with SDBs in the RDT&E and the Services and Construction areas at ESD, but the Supply and Equipment category indicates there is no opportunity to contract with SDBs. The Supply and Equipment contracting at the ESD must have unique characteristics which keeps it from contracting with SDBs. Perhaps the systems developed and produced at the ESD do not require

parts compatible with SDB abilities.

The greatest area for SDB contract potential in AFSC is in the Services and Construction category and especially at the ASD. There are definitely some unique characteristics of both these factor levels which allow SDB contracts to flourish. The worst area for SDB contract potential in the AFSC is in the Supply and Equipment category at the ESD. SDB potential in the area of Weapons and Ammunition also appears weak in the AFSC.

Based on this study, an organization which deals primarily in an area such as weapons and ammunition should not be mandated to meet the same goal for contracting with SDBs as other areas such as RDT&E because there are significant differences in the ability to meet the goal, based on the type of contracting effort and type of industry involved. Perhaps the solution is to make the goal particular to specific contracting groups based on the amount of SDB contracting opportunity. This is one area which warrants further research. The next section discusses more possible areas for further research.

Recommendations for Future Research

This study only looked at AFSC data for the years 1987-1989. Further research should include at least Air Force Logistics Command (AFLC) data since they perform most of the central procurement type contracting (replenishment spares,

modifications, sustaining engineering, repairs, overhauls, etc.). Ultimately, data from the entire AF, if not the DOD, should be analyzed in a similar fashion to obtain more accurate and generalizable results. More years should be analyzed (including those prior to 1987) in order to gather trend data to see if the percentages of SDB contracts have greatly increased. This would determine whether the mandate has had any effect on the percentages.

More detailed analysis should be conducted in the areas where high and low percentages of SDB contracting exist. This will provide insight into the unique characteristics of these areas to identify the factors that encourage or restrain SDB participation. This will identify ways to increase SDB participation in areas previously restricted. Further research into the reasons why the differences exist is warranted.

The conclusions had many speculations as to why the differences existed. If the reasons for the differences can be determined through analysis, the differences may be able to be minimized so SDBs from all areas of Federal contracting can be used to the greatest possible extent.

HISTOGRAM OF CELL1

LOW	HIGH	N	
0.000	0.100	105	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	1	
0.800	0.900	1	
0.900	1.000	1	
1.000	1.100	5	

CASES INCLUDED 113 MISSING CASES 0

HISTOGRAM OF CELL2

LOW	HIGH	N	
0.000	0.100	162	
0.100	0.200	0	
0.200	0.300	1	
0.300	0.400	2	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	6	

HISTOGRAM OF CELL3

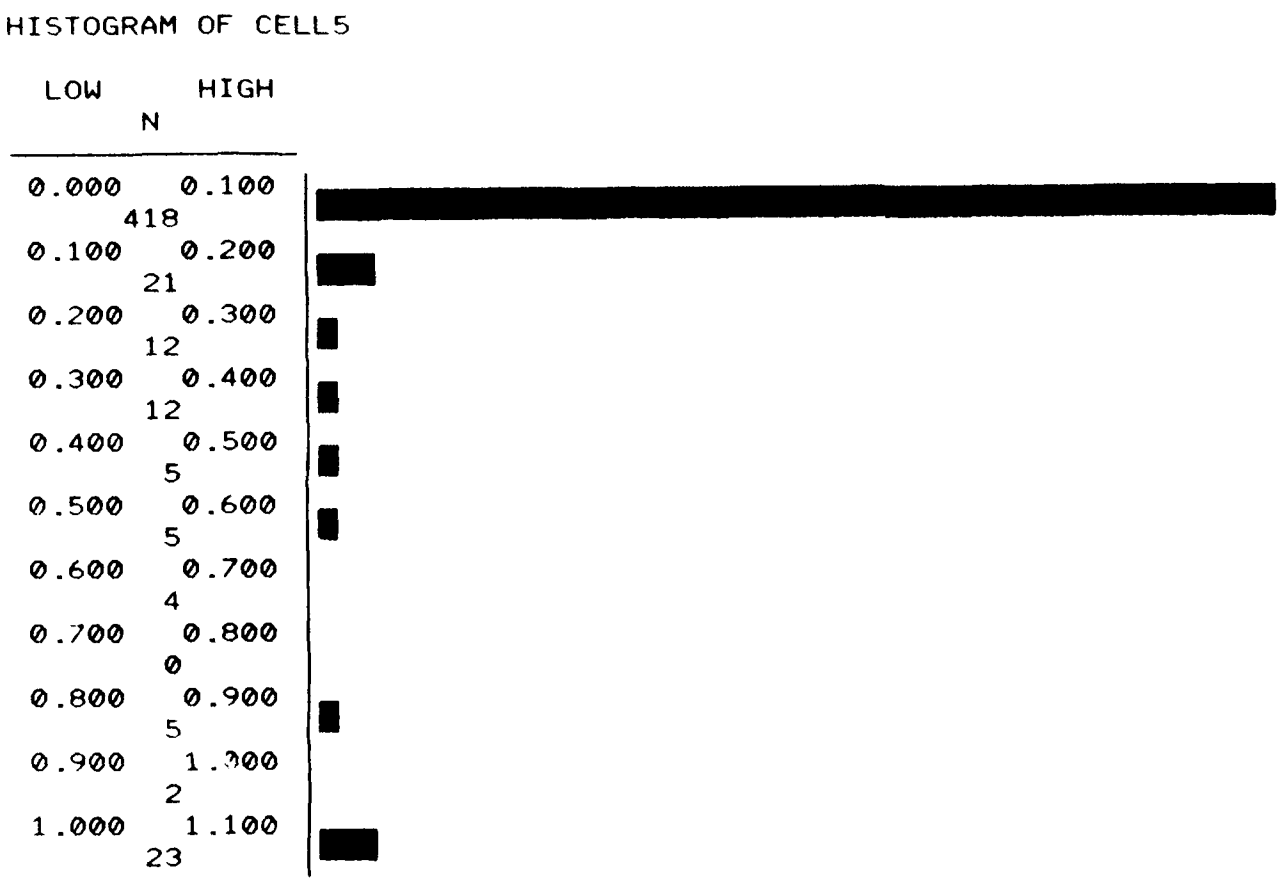
LOW	HIGH	N	
0.000	0.100	4	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

CASES INCLUDED 4 MISSING CASES 0

HISTOGRAM OF CELL4

LOW	HIGH	N	
0.000	0.100	92	
0.100	0.200	1	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	1	
0.700	0.800	0	
0.800	0.900	1	
0.900	1.000	0	
1.000	1.100	2	

HISTOGRAM OF CELL5



CASES INCLUDED 507 MISSING CASES 0

HISTOGRAM OF CELL6

LOW	HIGH	N	
0.000	0.100	31	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	15	

CASES INCLUDED 46 MISSING CASES 0

HISTOGRAM OF CELL7

LOW	HIGH	N	
0.000	0.100	45	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	8	

CASES INCLUDED 53 MISSING CASES 0

HISTOGRAM OF CELL8

LOW	HIGH	N	
0.000	0.100	2	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

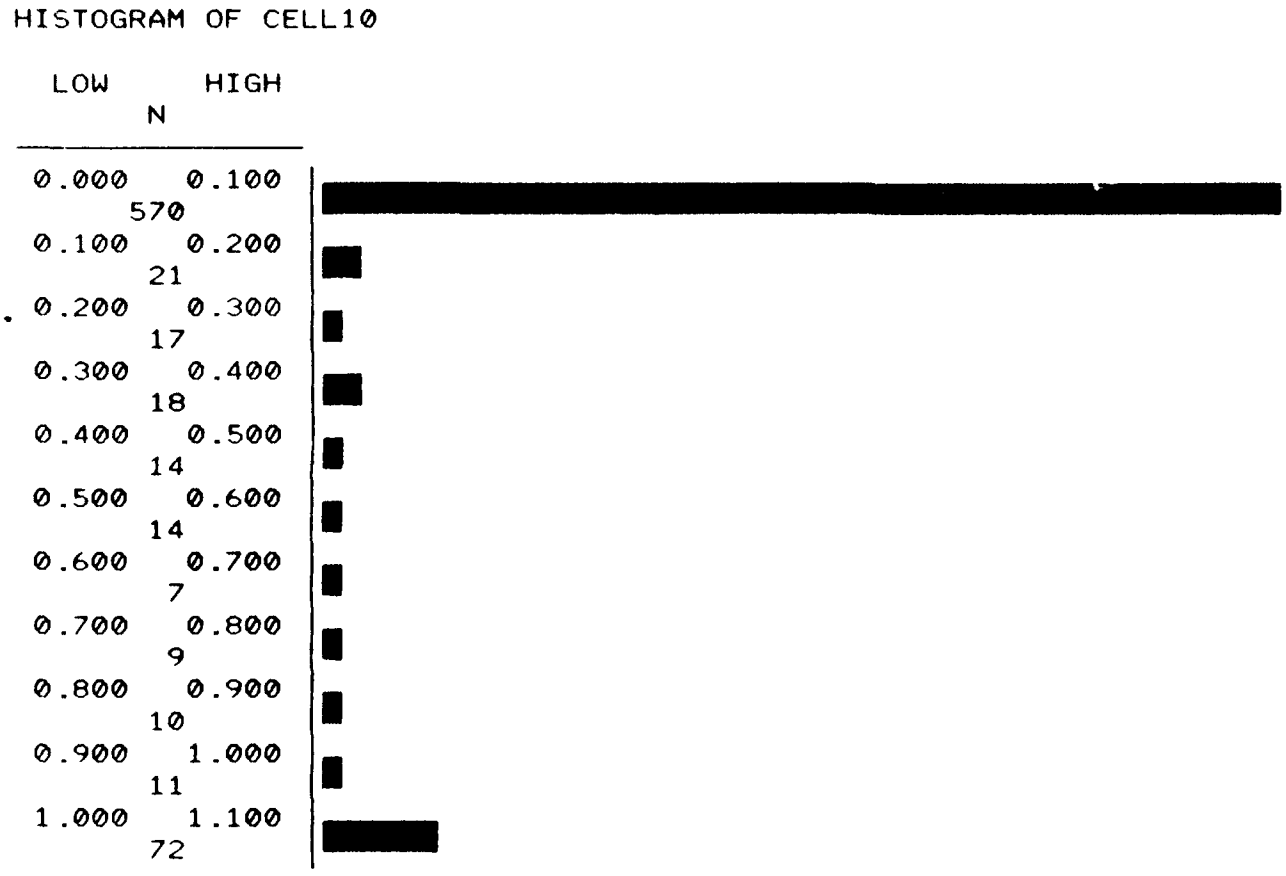
CASES INCLUDED 2 MISSING CASES 0

HISTOGRAM OF CELL9

LOW	HIGH	N	
0.000	0.100	38	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	1	
0.900	1.000	0	
1.000	1.100	8	

CASES INCLUDED 47 MISSING CASES 0

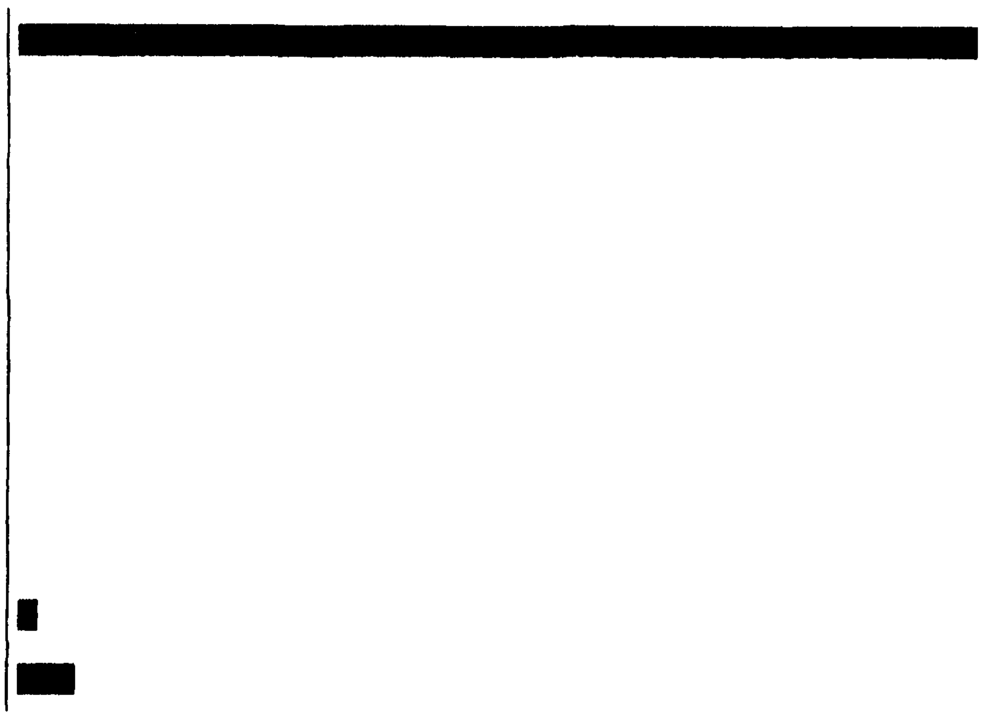
HISTOGRAM OF CELL10



CASES INCLUDED 763 MISSING CASES 0

HISTOGRAM OF CELL11

LOW	HIGH	N
0.000	0.100	172
0.100	0.200	0
0.200	0.300	1
0.300	0.400	0
0.400	0.500	0
0.500	0.600	0
0.600	0.700	0
0.700	0.800	0
0.800	0.900	1
0.900	1.000	2
1.000	1.100	10



CASES INCLUDED 186   MISSING CASES 0

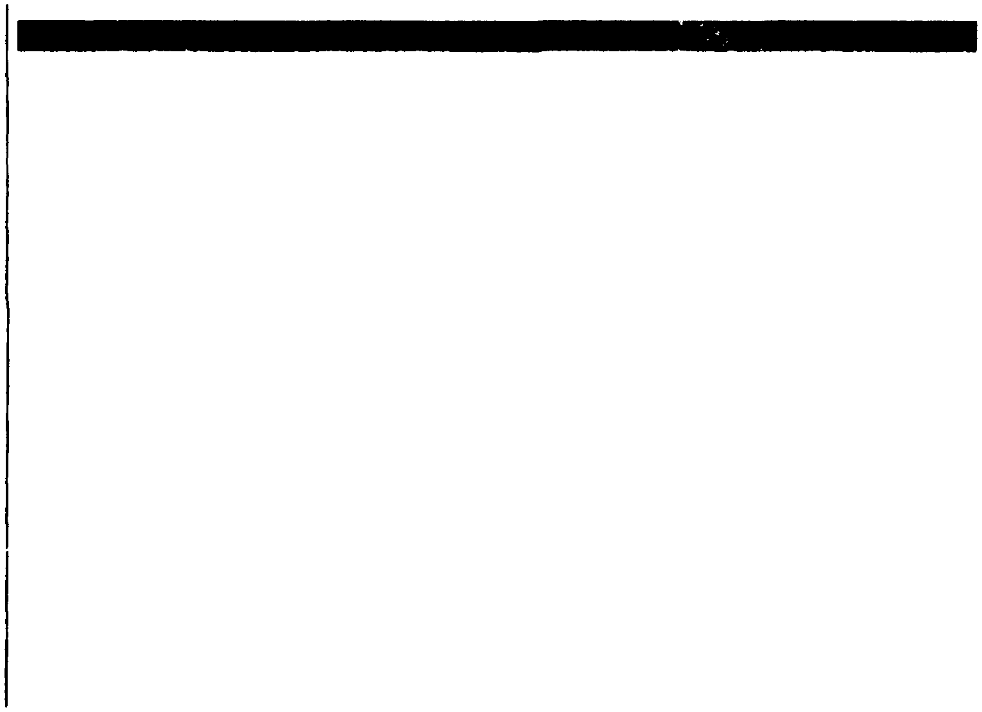
HISTOGRAM OF CELL12

LOW	HIGH	N	
0.000	0.100	96	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	1	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	4	

CASES INCLUDED 101 MISSING CASES 0

HISTOGRAM OF CELI 13

LOW	N	HIGH
0.000	4	0.100
0.100	0	0.200
0.200	0	0.300
0.300	0	0.400
0.400	0	0.500
0.500	0	0.600
0.600	0	0.700
0.700		0.800
0.800	0	0.900
0.900	0	1.000
1.000	0	1.100



CASES INCLUDED 4   MISSING CASES 0

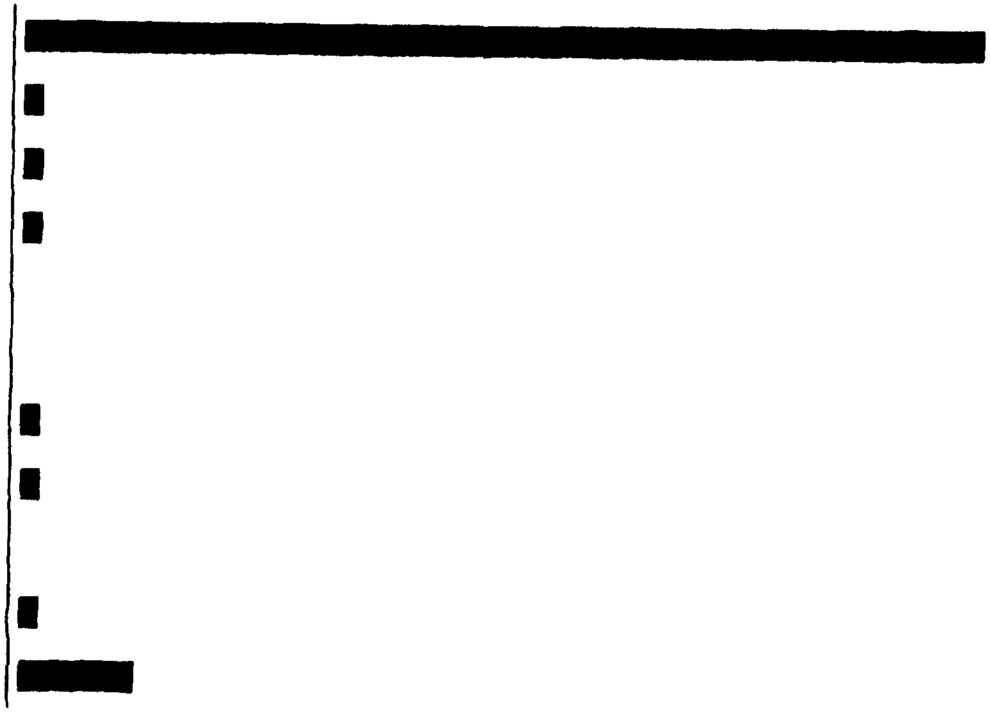
HISTOGRAM OF CELL14

LOW	HIGH	N	
0.000	0.100	66	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

CASES INCLUDED 66 MISSING CASES 0

HISTOGRAM OF CELL15

LOW	HIGH	N
0.000	0.100	555
0.100	0.200	9
0.200	0.300	9
0.300	0.400	7
0.400	0.500	4
0.500	0.600	2
0.600	0.700	6
0.700	0.800	6
0.800	0.900	4
0.900	1.000	6
1.000	1.100	66



CASES INCLUDED 674 MISSING CASES 0

HISTOGRAM OF CELL16

LOW	HIGH	N	
0.000	0.100	1	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

CASES INCLUDED 1 MISSING CASES 0

HISTOGRAM OF CELL17

LOW	HIGH	N	
0.000	0.100	2	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

CASES INCLUDED 2 MISSING CASES 0

HISTOGRAM OF CELL18

LOW	HIGH	N	
0.000	0.100	1	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

CASES INCLUDED 1 MISSING CASES 0

HISTOGRAM OF CELL19

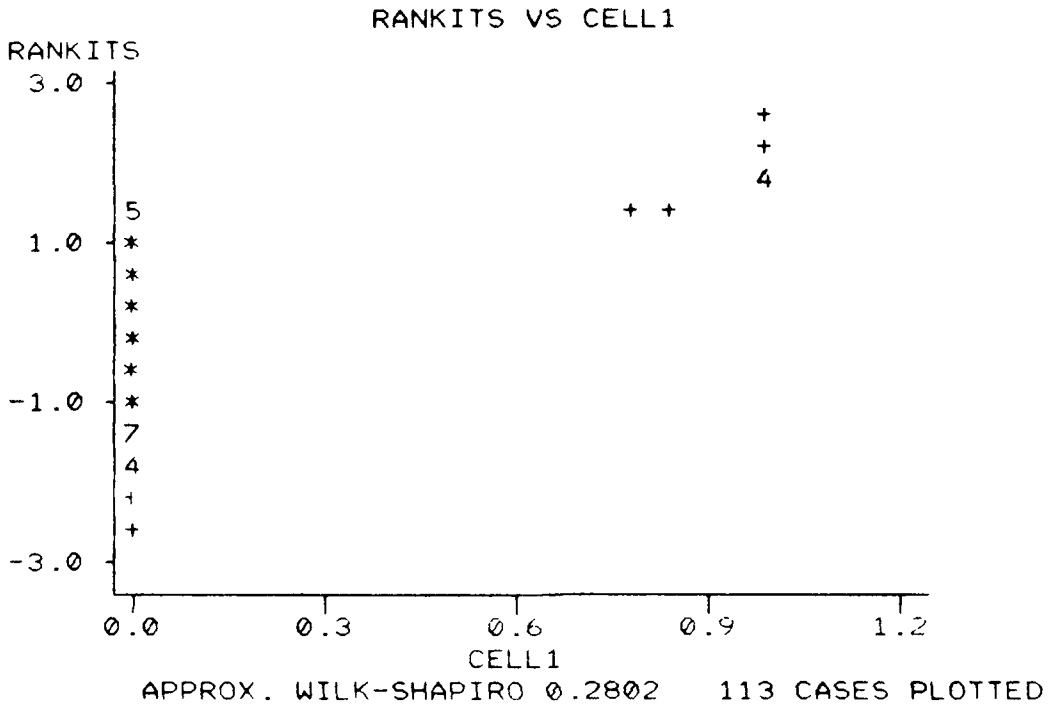
LOW	HIGH	N	
0.000	0.100	2	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	0	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

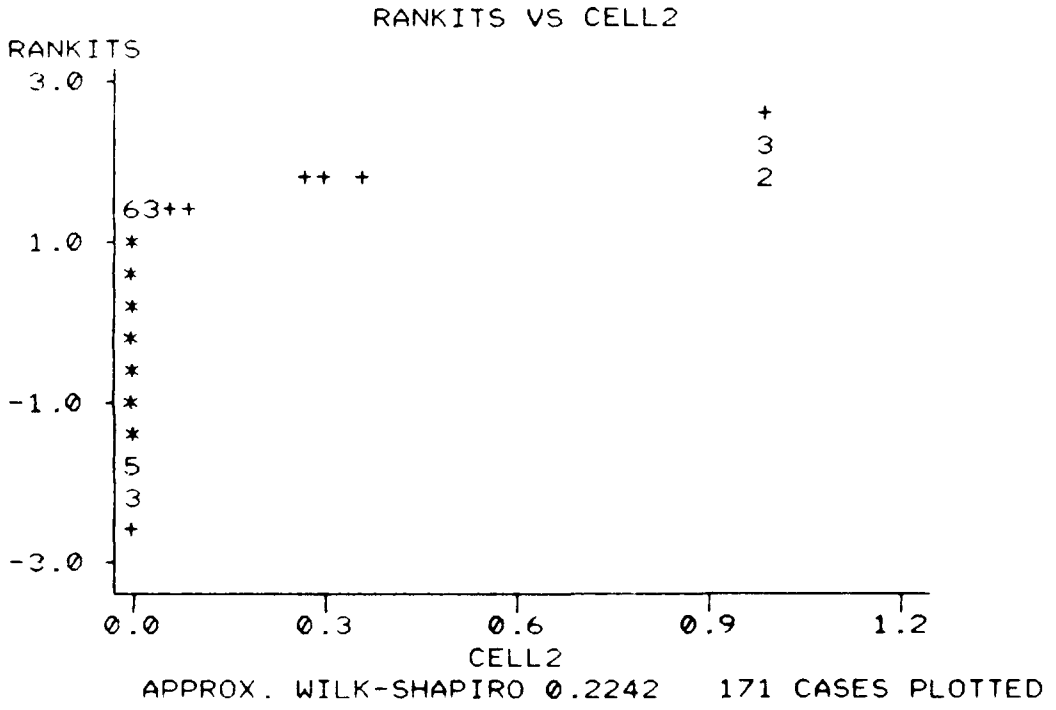
CASES INCLUDED 2 MISSING CASES 0

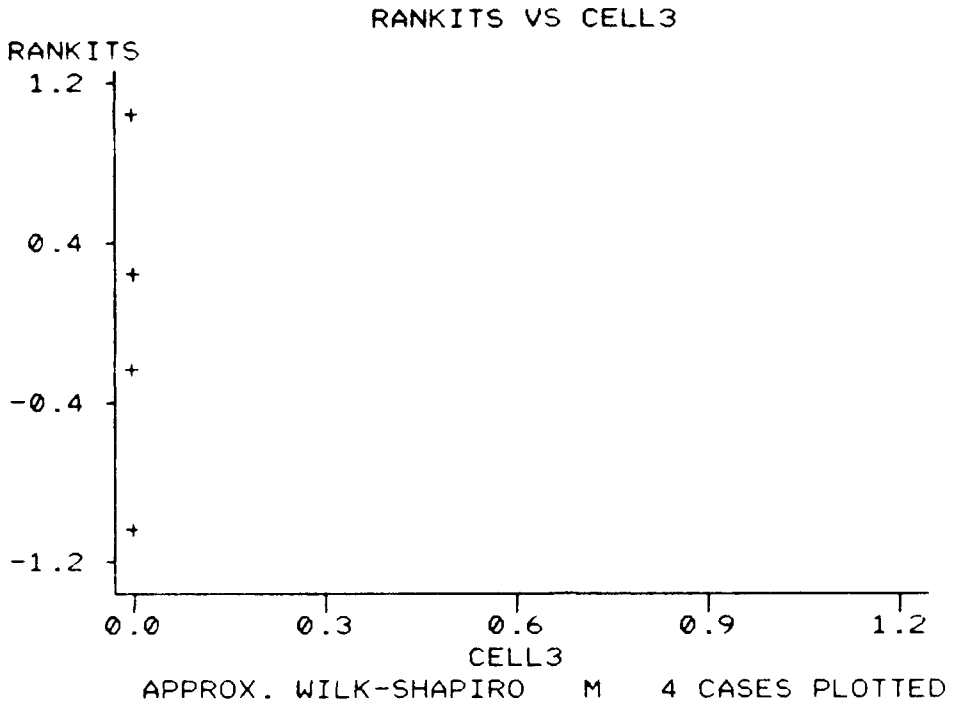
HISTOGRAM OF CELL20

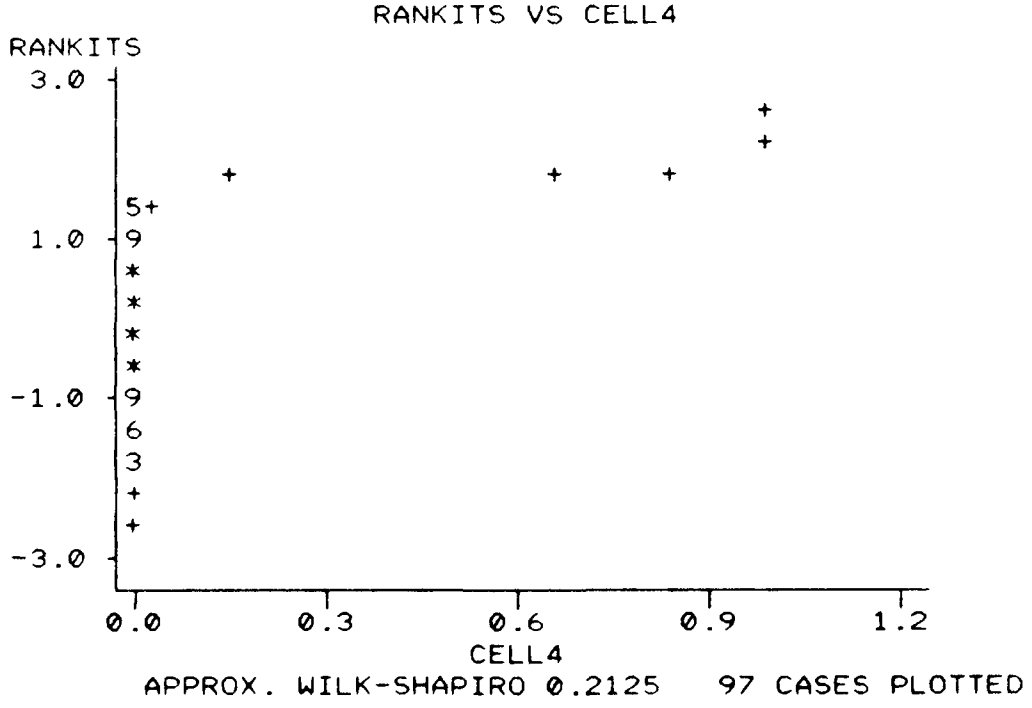
LOW	HIGH	N	
0.000	0.100	5	
0.100	0.200	0	
0.200	0.300	0	
0.300	0.400	0	
0.400	0.500	0	
0.500	0.600	1	
0.600	0.700	0	
0.700	0.800	0	
0.800	0.900	0	
0.900	1.000	0	
1.000	1.100	0	

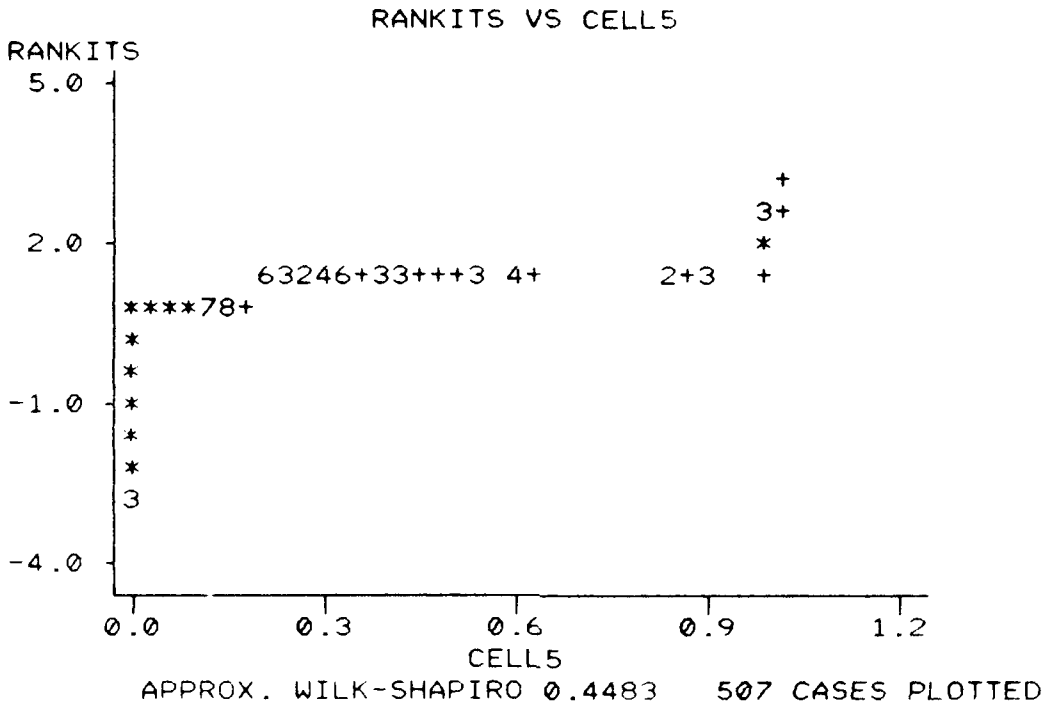
CASES INCLUDED 6 MISSING CASES 0

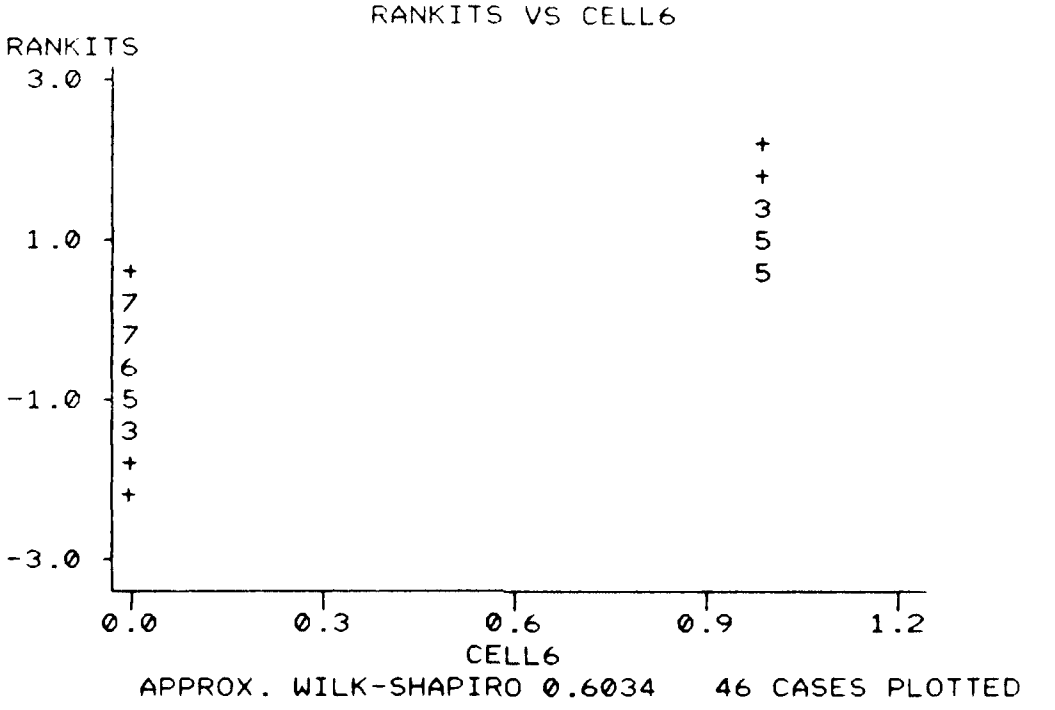

RANKITS VS CELL1
RANKITS
3.0
1.0
-1.0
-3.0
0.0
0.3
0.6
0.9
1.2
CELL1
APPROX. WILK-SHAPIRO 0.2802 113 CASES PLOTTED


RANKITS VS CELL2
RANKITS
3.0
1.0
-1.0
-3.0
0.0
0.3
0.6
0.9
1.2
CELL2
APPROX. WILK-SHAPIRO 0.2242 171 CASES PLOTTED

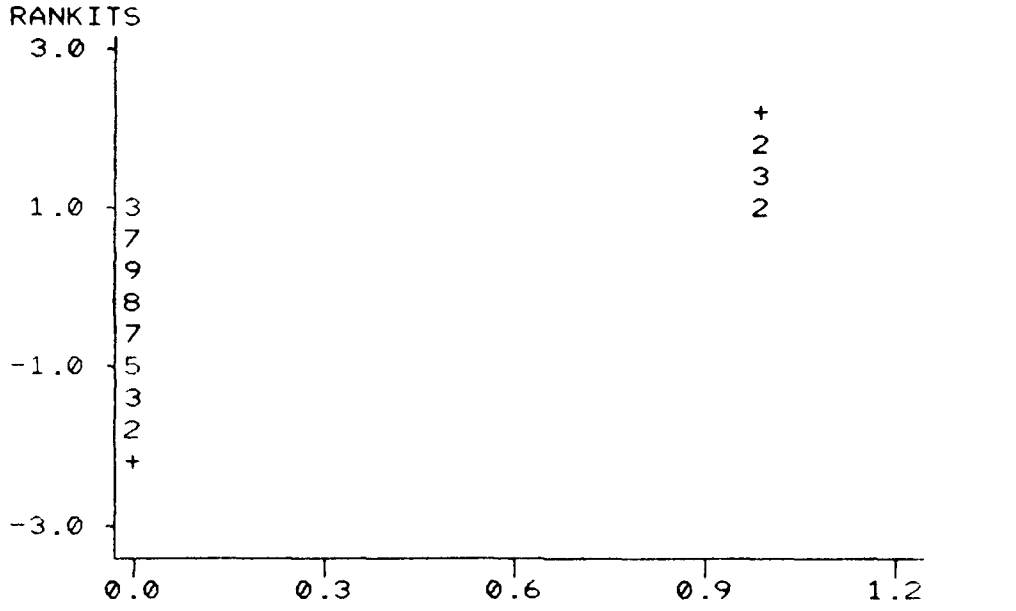

RANKITS VS CELL3
RANKITS
1.2
0.4
-0.4
-1.2
0.0
0.3
0.6
0.9
1.2
CELL3
APPROX. WILK-SHAPIRO M 4 CASES PLOTTED


RANKITS VS CELL4
RANKITS
3.0
1.0
-1.0
-3.0
0.0
0.3
0.6
0.9
1.2
CELL4
APPROX. WILK-SHAPIRO 0.2125 97 CASES PLOTTED


RANKITS VS CELL5
RANKITS
5.0
2.0
-1.0
-4.0
63246+33+++3 4+
2+3
****78+
0.0
0.3
0.6
0.9
1.2
CELL5
APPROX. WILK-SHAPIRO 0.4483 507 CASES PLOTTED

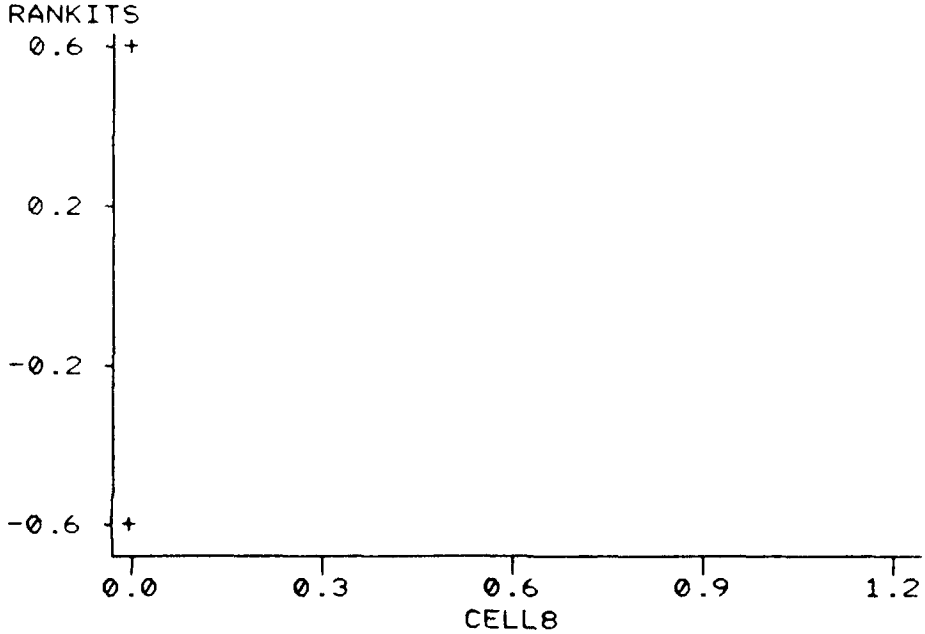

RANKITS VS CELL6
RANKITS
3.0
1.0
-1.0
-3.0
0.0
0.3
0.6
0.9
1.2
CELL6
APPROX. WILK-SHAPIRO 0.6034 46 CASES PLOTTED

RANKITS VS CELL7

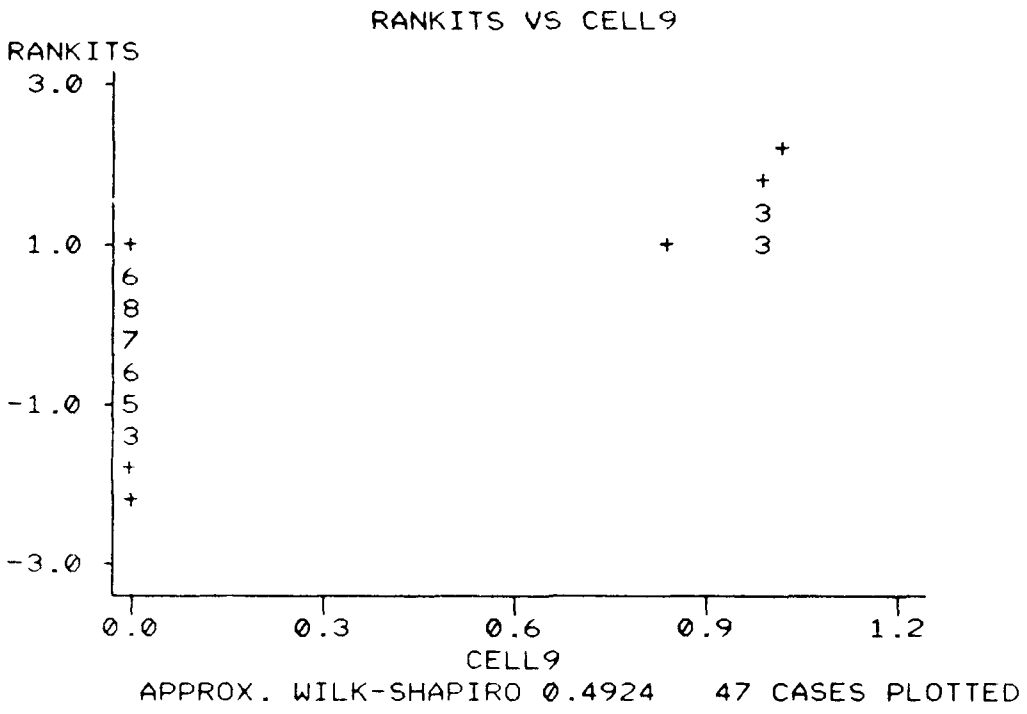


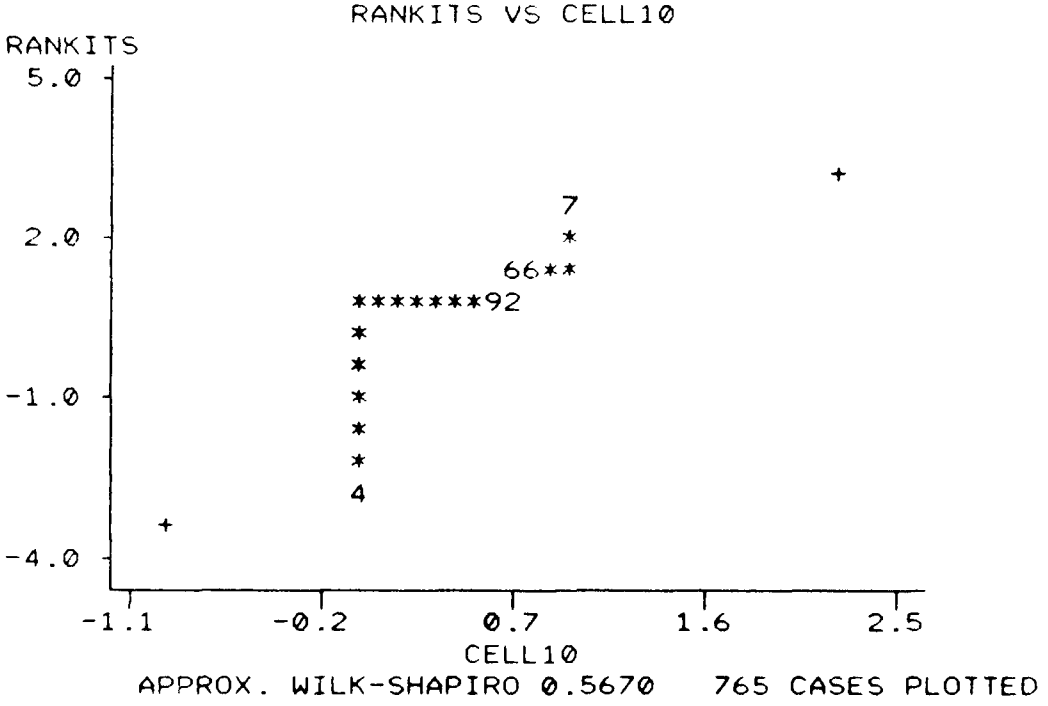
APPROX. WILK-SHAPIRO 0.4306 53 CASES PLOTTED

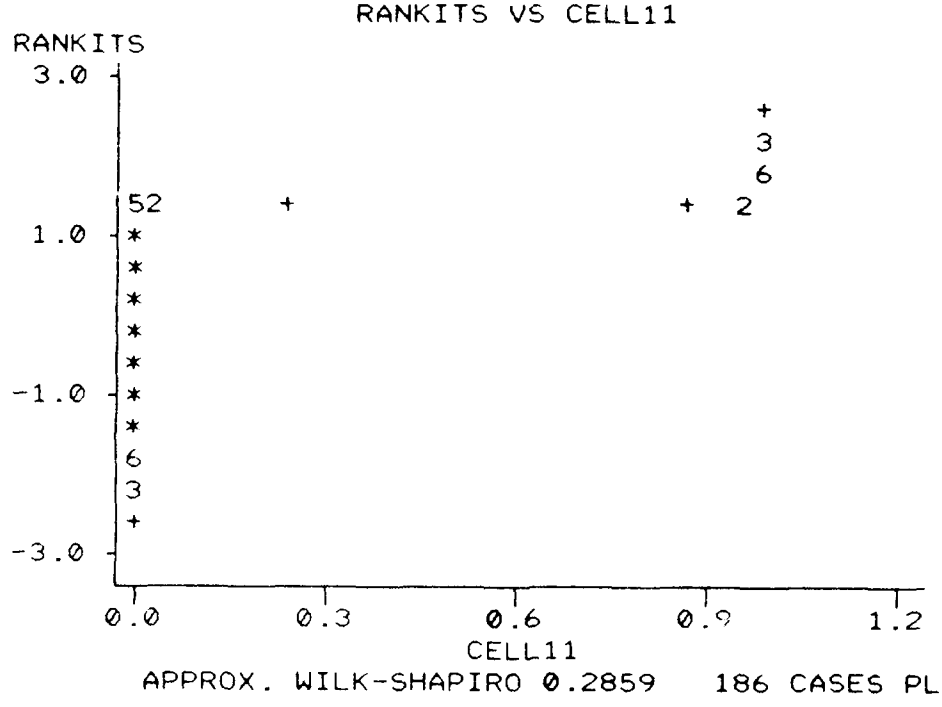
RANKITS VS CELL8



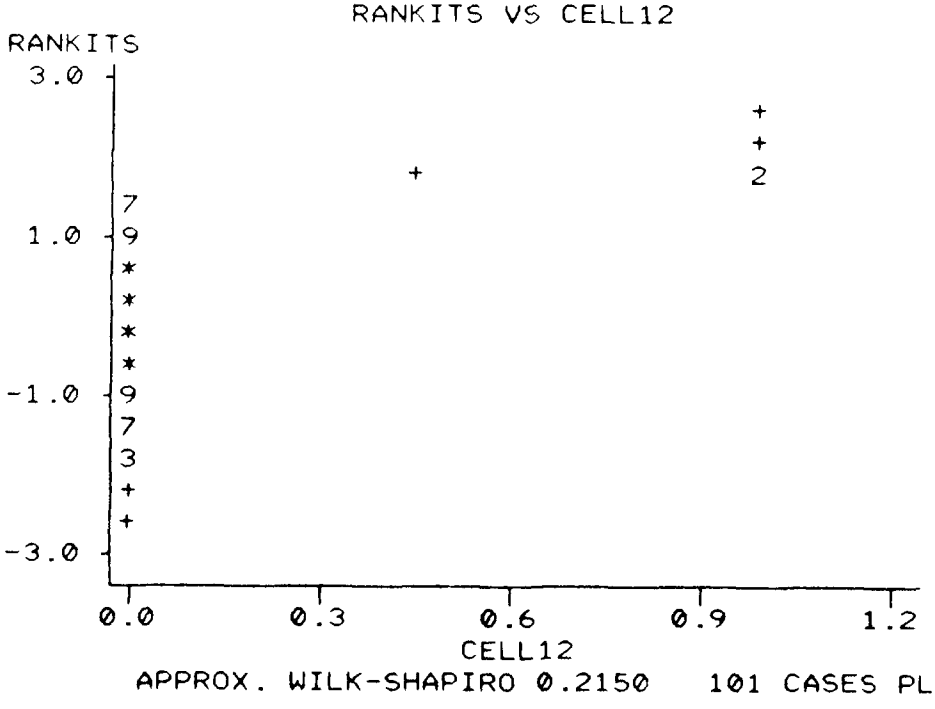
APPROX. WILK-SHAPIRO M 2 CASES PLOTTED


RANKITS VS CELL9
RANKITS
3.0
1.0
-1.0
-3.0
0.0
0.3
0.6
0.9
1.2
CELL9
APPROX. WILK-SHAPIRO 0.4924 47 CASES PLOTTED

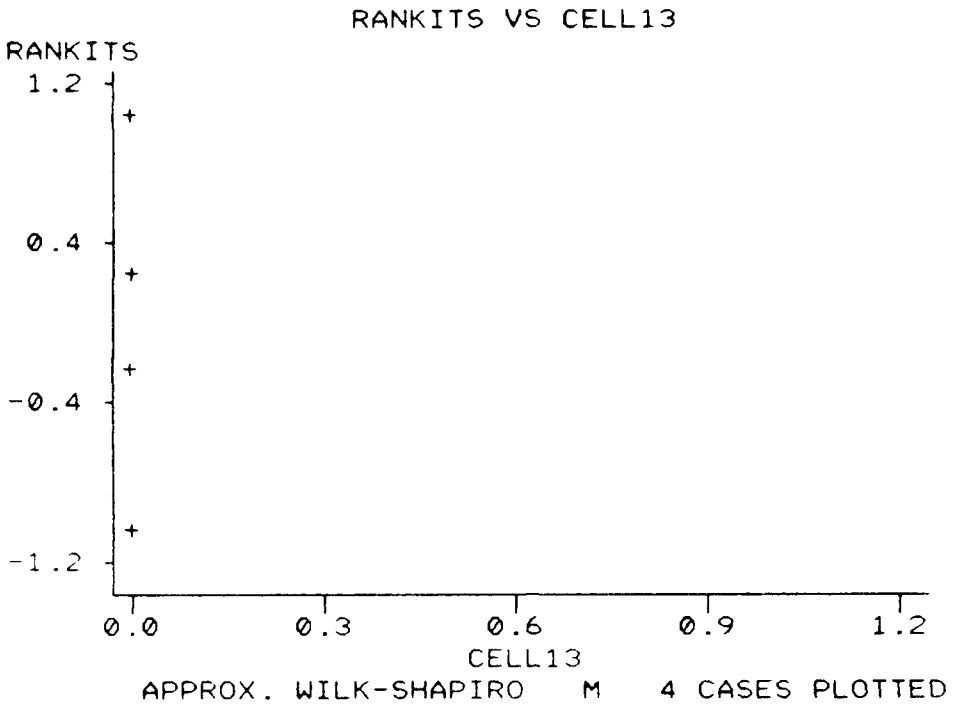

RANKITS VS CELL10
RANKITS
5.0
2.0
-1.0
-4.0
-1.1
-0.2
0.7
1.6
2.5
CELL10
APPROX. WILK-SHAPIRO 0.5670 765 CASES PLOTTED

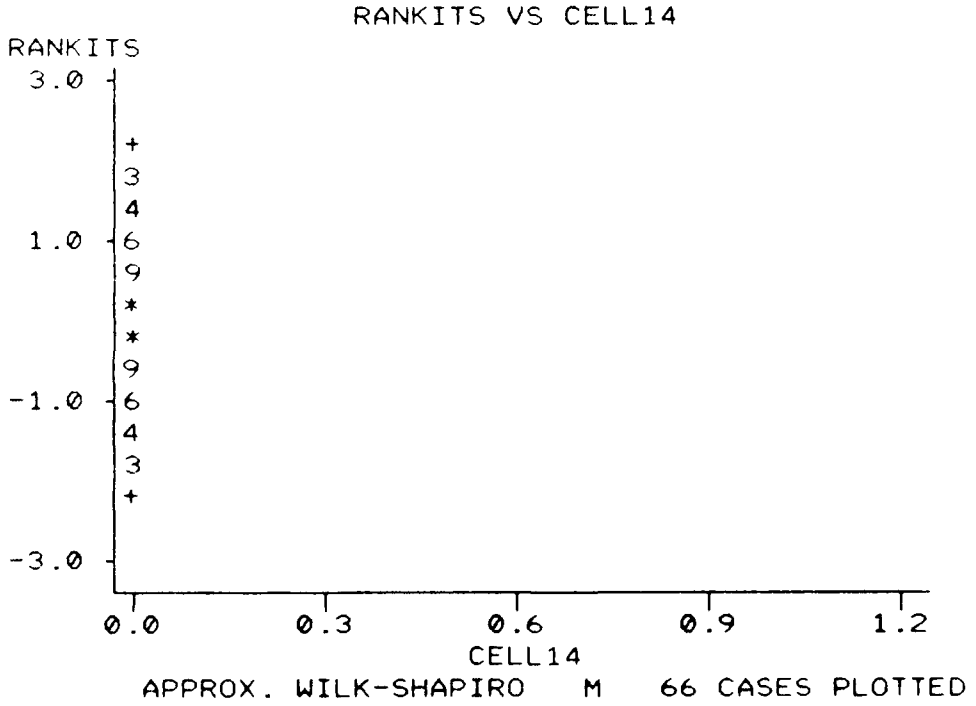


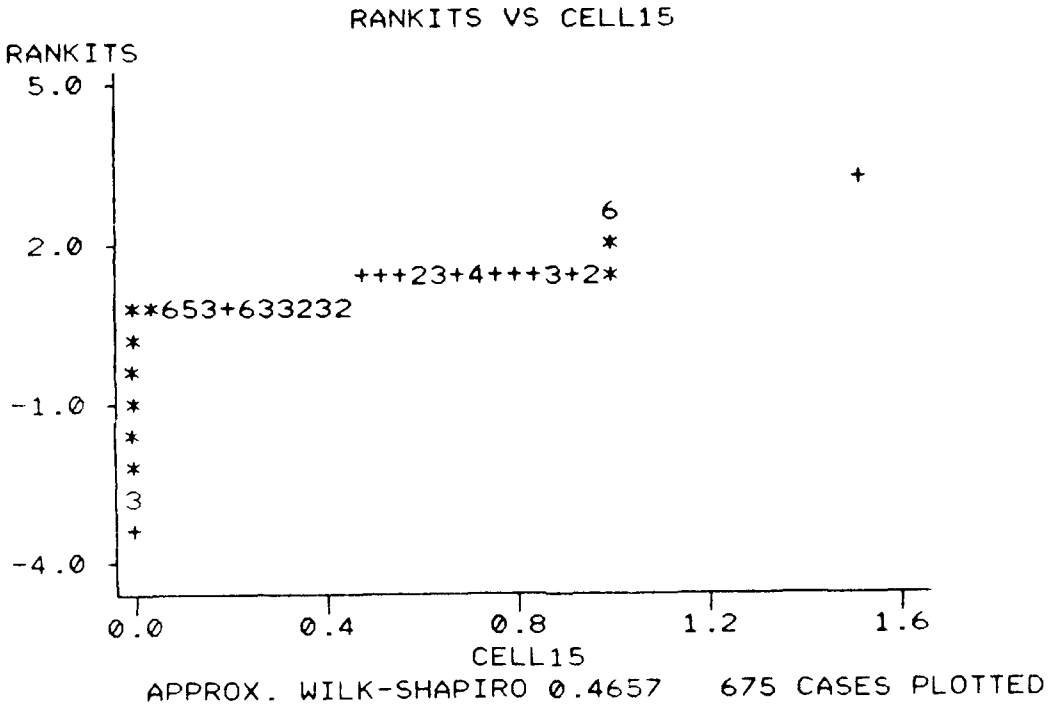
APPROX. WILK-SHAPIRO 0.2859 186 CASES PLOTTED

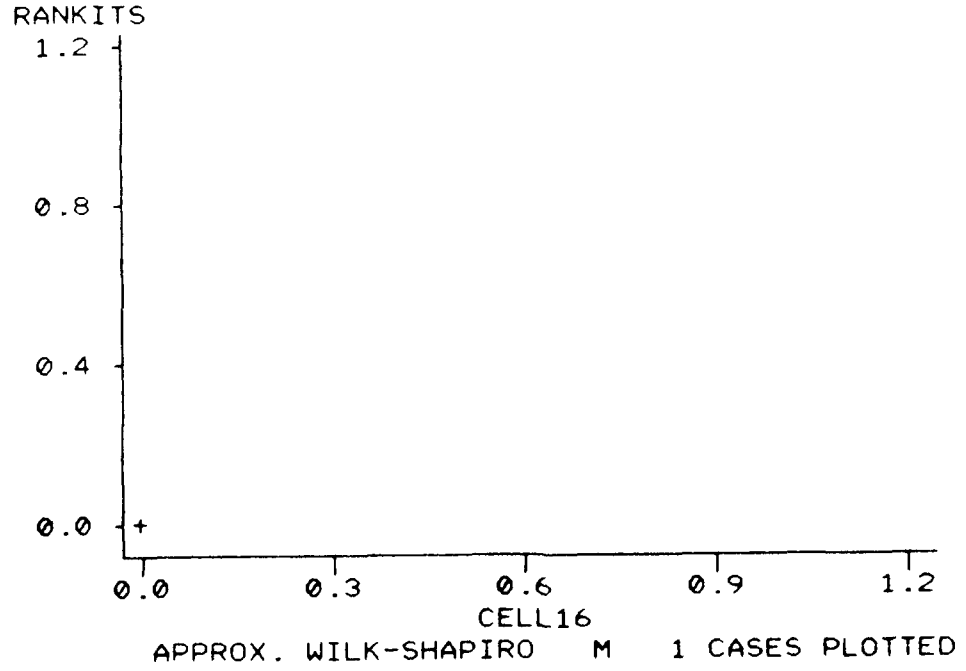


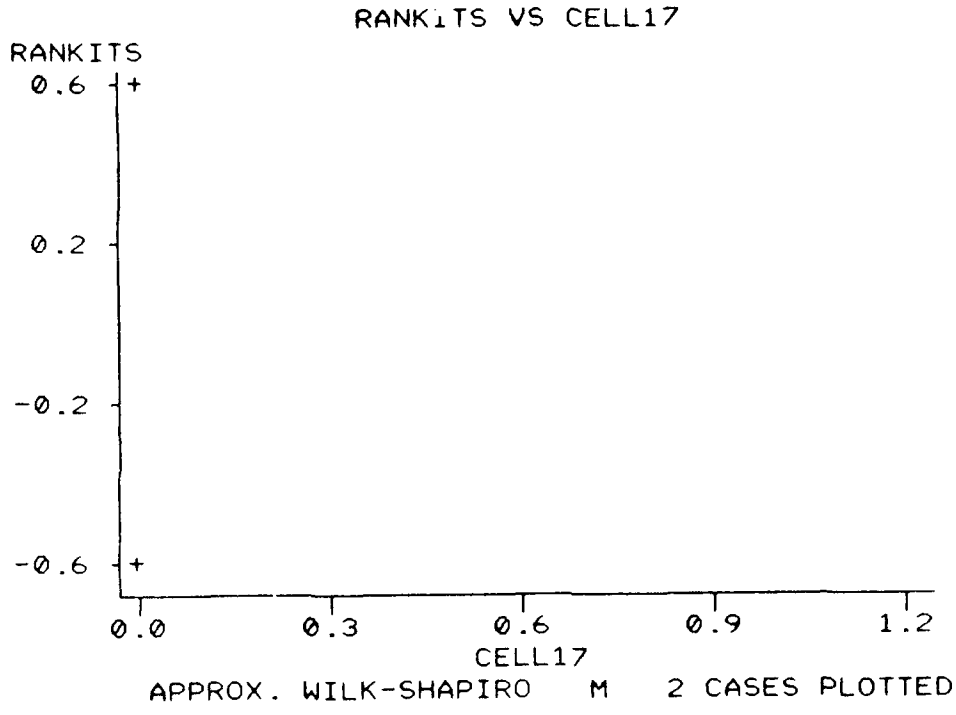
APPROX. WILK-SHAPIRO 0.2150 101 CASES PLOTTED

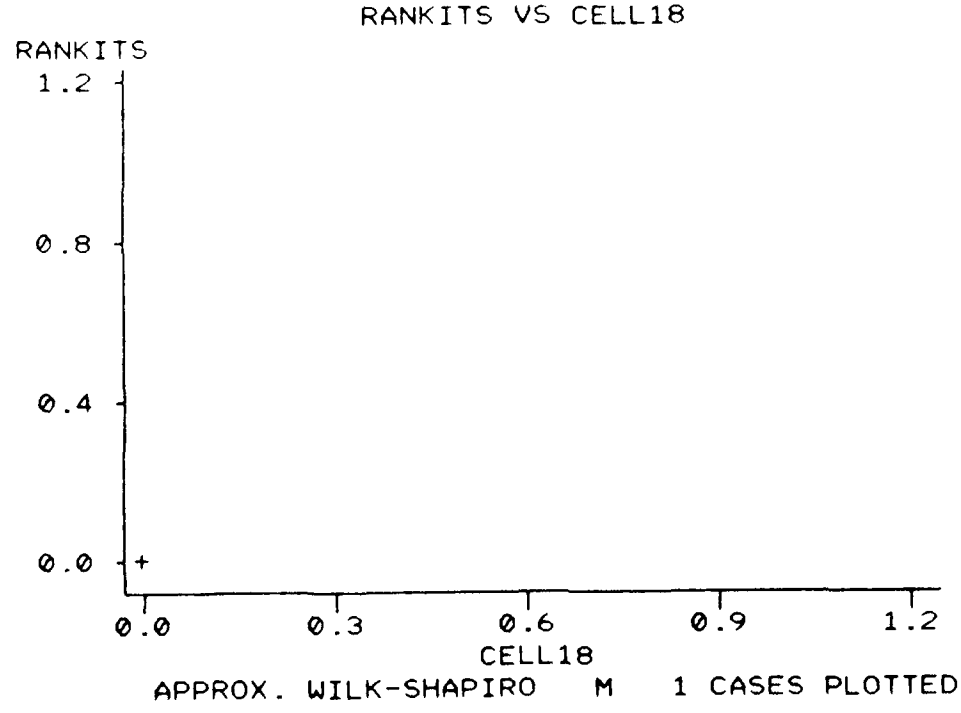

RANKITS VS CELL13
RANKITS
1.2
0.4
-0.4
-1.2
0.0
0.3
0.6
0.9
1.2
CELL13
APPROX. WILK-SHAPIRO M 4 CASES PLOTTED

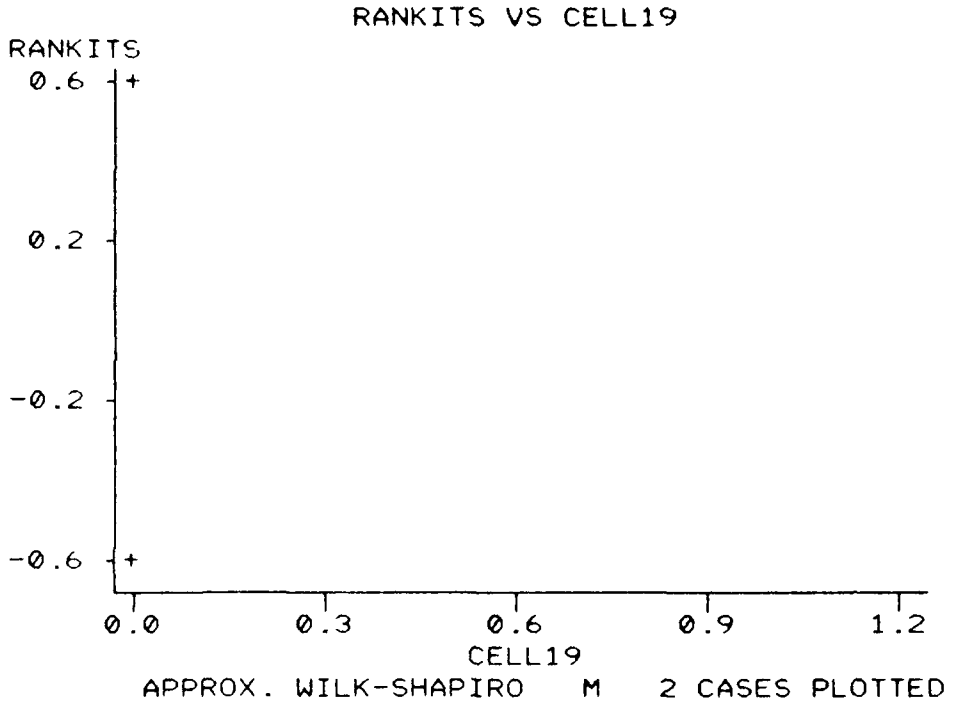

RANKITS VS CELL14
RANKITS
3.0
1.0
-1.0
-3.0
0.0
0.3
0.6
0.9
1.2
CELL14
APPROX. WILK-SHAPIRO M 66 CASES PLOTTED

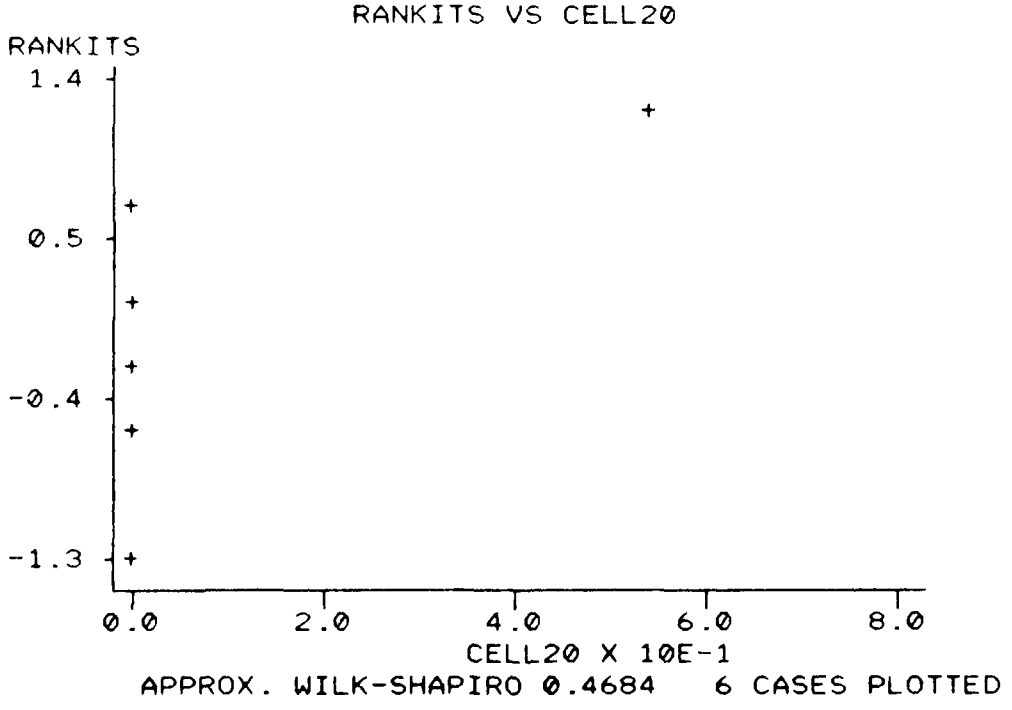

RANKITS VS CELL15
RANKITS
5.0
2.0
-1.0
-4.0
6
*
+++23+4+++3+2*
**653+633232
*
*
*
*
*
3
+
0.0
0.4
0.8
1.2
1.6
CELL15
APPROX. WILK-SHAPIRO 0.4657 675 CASES PLOTTED


RANKITS VS CELL16
RANKITS
1.2
0.8
0.4
0.0
+
0.0
0.3
0.6
0.9
1.2
CELL16
APPROX. WILK-SHAPIRO M 1 CASES PLOTTED


RANKITS VS CELL17
RANKITS
0.6
0.2
-0.2
-0.6
0.0
0.3
0.6
0.9
1.2
CELL17
APPROX. WILK-SHAPIRO M 2 CASES PLOTTED


RANKITS VS CELL18
RANKITS
1.2
0.8
0.4
0.0
0.0
0.3
0.6
0.9
1.2
CELL18
APPROX. WILK-SHAPIRO M 1 CASES PLOTTED


RANKITS VS CELL19
RANKITS
0.6
0.2
-0.2
-0.6
0.0
0.3
0.6
0.9
1.2
CELL19
APPROX. WILK-SHAPIRO M 2 CASES PLOTTED


RANKITS VS CELL20
RANKITS
1.4
0.5
-0.4
-1.3
0.0
2.0
4.0
6.0
8.0
CELL20 X 10E-1
APPROX. WILK-SHAPIRO 0.4684 6 CASES PLOTTED

Appendix B: QUATTRO Output

Confidence Intervals Generated by QUATTRO

Across FSC codes and SEC A&E code

```
-0.3104 <= mu.1 - mu.2 <= -0.2074
-0.0381 <= mu.1 - mu.3 <=  0.0321
-0.1050 <= mu.1 - mu.4 <=  0.2395
 7.8813 <= mu.2 - mu.3 <=  7.9783
 0.0284 <= mu.2 - mu.4 <=  0.6237
-0.2250 <= mu.3 - mu.4 <=  0.3655
```

Across FSC codes and SEC M&R code

```
-0.1545 <= mu.1 - mu.2 <= -0.0629
-0.0385 <= mu.1 - mu.3 <=  0.0346
-0.1051 <= mu.1 - mu.4 <=  0.1896
 0.0573 <= mu.2 - mu.3 <=  0.1562
-0.0589 <= mu.2 - mu.4 <=  0.3608
-0.1638 <= mu.3 - mu.4 <=  0.2522
-0.3042 <= mu.1 - mu.2 <=  0.3042
```

Across FSC codes and SEC W&A code

```
-0.2484 <= mu.1 - mu.3 <=  0.2484
-0.2683 <= mu.1 - mu.4 <=  0.2683
-0.3042 <= mu.2 - mu.3 <=  0.3042
-0.4302 <= mu.2 - mu.4 <=  0.4302
-0.3927 <= mu.3 - mu.4 <=  0.3927
```

Across FSC code and SEC E code

```
-0.2023 <= mu.1 - mu.2 <= -0.0976
-0.0086 <= mu.1 - mu.3 <=  0.0854
-0.1342 <= mu.1 - mu.4 <=  0.2111
 0.1322 <= mu.2 - mu.3 <=  0.2446
-0.1092 <= mu.2 - mu.4 <=  0.4860
-0.2967 <= mu.3 - mu.4 <=  0.2967
```

Across FSC code and SEC O code

```
-0.0942 <= mu.1 - mu.2 <= -0.0608
-0.0604 <= mu.1 - mu.3 <= -0.0262
-0.0347 <= mu.1 - mu.4 <=  0.0494
 0.0188 <= mu.2 - mu.3 <=  0.0496
-0.0345 <= mu.2 - mu.4 <=  0.2043
-0.0688 <= mu.3 - mu.4 <=  0.1701
```

Across SEC codes and FSC RDT&E code

```
-0.0103 <= mu.1 - mu.2 <=  0.0603
-0.0826 <= mu.1 - mu.3 <=  0.2170
-0.0115 <= mu.1 - mu.4 <=  0.0691
-0.0605 <= mu.1 - mu.5 <=  0.0001
-0.1057 <= mu.2 - mu.3 <=  0.1901
-0.0332 <= mu.2 - mu.4 <=  0.0408
-0.0809 <= mu.2 - mu.5 <= -0.0294
-0.1892 <= mu.3 - mu.4 <=  0.1123
-0.2436 <= mu.3 - mu.5 <=  0.0488
-0.0913 <= mu.4 - mu.5 <= -0.0267
```

Across SEC codes and FSC S&C code

```
 0.1156 <= mu.1 - mu.2 <=  0.2347
 0.1088 <= mu.1 - mu.3 <=  0.5433
 0.0764 <= mu.1 - mu.4 <=  0.1990
 0.1069 <= mu.1 - mu.5 <=  0.1954
-0.0634 <= mu.2 - mu.3 <=  0.3653
-0.0967 <= mu.2 - mu.4 <=  0.0217
-0.0653 <= mu.2 - mu.5 <=  0.0174
-0.4056 <= mu.3 - mu.4 <=  0.0288
-0.3812 <= mu.3 - mu.5 <=  0.0313
-0.0303 <= mu.4 - mu.5 <=  0.0573
```

Across SEC codes and FSC S&E code

```
-0.0100 <= mu.1 - mu.2 <=  0.0621
-0.0770 <= mu.1 - mu.3 <=  0.2174
 0.0285 <= mu.1 - mu.4 <=  0.1120
-0.0946 <= mu.1 - mu.5 <= -0.0463
-0.1043 <= mu.2 - mu.3 <=  0.1927
-0.0019 <= mu.2 - mu.4 <=  0.0903
-0.1276 <= mu.2 - mu.5 <= -0.0654
-0.1533 <= mu.3 - mu.4 <=  0.1533
-0.2868 <= mu.3 - mu.5 <=  0.0054
-0.1783 <= mu.4 - mu.5 <= -0.1031
```

Across SEC codes and FSC uncoded code

```
-0.5796 <= mu.1 - mu.2 <=  0.5796
-0.9043 <= mu.1 - mu.3 <=  0.9043
-0.9043 <= mu.1 - mu.4 <=  0.9043
-0.4695 <= mu.1 - mu.5 <=  0.2894
-0.5796 <= mu.2 - mu.3 <=  0.5796
-0.5796 <= mu.2 - mu.4 <=  0.5796
-0.3700 <= mu.2 - mu.5 <=  0.1899
-0.9043 <= mu.3 - mu.4 <=  0.9043
-0.4695 <= mu.3 - mu.5 <=  0.2894
-0.4695 <= mu.4 - mu.5 <=  0.2894
```

Bibliography

1. Arnavas, Donald P. and Ruberry, William J. Government Contract Guidebook. Federal Publications, Washington DC, 1987.

2. Bjork, Gordon C. Private Enterprise and Public Interest: the Development of American Capitalism. Englewood Cliffs NJ: Prentice-Hall Inc., 1969.

3. Black, Dennis E. "Socioeconomic Contract Goal Setting Within the Department of Defense: Promises Still Unfulfilled," National Contract Management Journal, 22: 67-82 (Winter 89).

4. Chamberlain, Edward. "Product Heterogeneity and Public Policy," Readings in Industrial Organization and Public Policy, edited by Richard B. Heflebower and George W. Stocking. Homeward IL: Richard D. Irwin Inc., 1958.

5. Culver, Walter J. "The Federal Small Business Program: Does It Really Serve the National Interest," Government Executive, 16: 23-25 (May 84).

6. Dixon, Senator Alan J. Comments in National Defense, LXXIII: 14 (December 1988).

7. Dollinger, Marc J. and Catherine M. Daily. Purchasing From Small Minority-Owned Firms: Corporate Problems. Center for Advanced Purchasing Studies, Tempe AZ, 1989.

8. Edelmann, Steve. "What Makes America Great," National Defense, LXXIII: 31-32 (December 1988).

9. Emory, C. William. Business Research Methods (Third Edition). Homewood IL: Richard D. Irwin Inc., 1985.

10. Gamble, Maj B. R. An Analysis of Minority & Small Business Development, with Emphasis on the Air Force's Participation In the Section 8(a) Minority and Small Business Development Program. Research Study, Air Force Section, U.S. Army Command and Staff College, Fort Leavenworth KS, May 1979 (AD-A075440).

11. Gansler, Jacques S. Affording Defense. Cambridge: MIT Press, 1989.

12. Keyes, W. Noel. Dictionary of Terms In Federal Acquisition Regulation (FAR). New York: Oceana Publications, Inc., 1985.

13. "Legislative History," US Congressional and Administrative News: 5640 (December 1978).

14. Lorette, Richard J. et al. "The Small Business Administration: Why It's In Trouble," Government Executive, 18: 38-39 (May-June 1986).

15. Lubkin, Yale J. "The Roaring Mouse," National Defense, LXXIII: 33-34 (December 1988).

16. Magnotti, John F. Jr. "The Small Business Administration's Pilot Program: A Study In Frustration," National Contract Management Journal, 20: 61-65 (Summer 1986).

17. Mansfield, Edwin. Microeconomics: Theory/Applications (Sixth Edition). New York: WW Norton & Company, 1988.

18. McNabb, Dale E. et al. "On the Utilization of the DOD Acquisition System for Socio-Economic Policy Implementation," National Contract Management Journal, 15: 21-35 (Winter 1982).

19. Myers, Jerome L. Fundamentals of Experimental Design (Third Edition). Boston: Allen and Bacon, Inc., 1979.

20. Neter, John et al. Applied Linear Statistical Models (Second Edition). Homewood IL: Richard D. Irwin, Inc., 1985.

21. Peck, Morton J. and Frederic M. Scherer. The Weapon Acquisition Process: An Economic Analysis. Boston: Harvard University Press, 1962.

22. Purchasing Performance Benchmarks, for the US Food Service Industry (1988). ISSN #1048-4086. Center for Advanced Purchasing Studies, Tempe AZ, January 1990.

23. Purchasing Performance Benchmarks, for the US Semiconductor Industry. ISSN #1050-0731. Center for Advanced Purchasing Studies, Tempe AZ, 1990.

24. Scherer, Frederic M. The Weapons Acquisition Process: Economic Incentives. Boston: Harvard University Press, 1964.

25. Stansberry, Maj Gen James W. "Minority Businesses Taking Wing Under the AF," Defense Management Journal, 14: 40-43 (January 1978).

26. White, Charles E. An Assessment of Public Law 95-507. MS Thesis, Naval Postgraduate School, Monterey CA, December 1980 (AD-A106093).

27. U. S. Congress. "Public Law 95-507, An Act: Amendment to the Small Business Act of 1957," U.S. Congressional Code and Administrative News, 95th Congress, 1st Session, No. 11a, Dec. 1978. St Paul MN: West Publishing Co., 1979.

28. ------. "Public Law 97-219, An Act: The Small Business Innovation Development Act of 1982," U.S. Congressional Code and Administrative News, 97th Congress, 2nd Session, Volume 1. St Paul MN: West Publishing Co., 1983.

29. ------. "Public Law 99-500, An Act: Continuing Appropriations Act for Fiscal Years 1982 and 1983," U.S. Congressional Code and Administrative News, 99th Congress, 2nd Session, Volume 3. St Paul MN: West Publishing Co., 1987.

30. ------. "Public Law 99-591, An Act: Continuing Appropriations Act for Fiscal Years 1982 and 1983," U.S. Congressional Code and Administrative News, 99th Congress, 2nd Session, Volume 3. St Paul MN: West Publishing Co., 1987.

31. ------. "Public Law 99-661, An Act: The National Defense Authorization Act for Fiscal Years 1982 and 1983," U.S. Congressional Code and Administrative News, 99th Congress, 2nd Session, Volume 3. St Paul MN: West Publishing Co., 1987.

32. ------. "Public Law 100-180, An Act: The National Defense Authorization Act for Fiscal Years 1986 and 1987," U.S. Congressional Code and Administrative News, 100th Congress, 1st Session, Volume 3. St Paul MN: West Publishing Co., 1987.

33. ------. "Public Law 100-656, An Act: Business Development Reform Act," U.S. Congressional Code and Administrative News, 100th Congress, 2nd Session, Volume 3. St Paul MN: West Publishing Co., 1988.

34. ------. "Public Law 101-165, An Act: Continuing Appropriations Act for Fiscal Years 1988 and 1989," U.S. Congressional Code and Administrative News, 101st Congress, 1st Session, No. 10, Jan 1990. St Paul MN: West Publishing Co, 1990.

35. ------. "Senate Report (Small Business Committee) No. 95-1070," U.S. Congressional Code and Administrative News, 95th Congress, 1st Session, No. 11a, Legislative History, Dec 1978. St Paul MN: West Publishing Co., 1979.

36. ------. "Senate Report (Small Business Committee) No. 97-194," U.S. Congressional Code and Administrative News, 97th Congress, 2nd Session, Volume 2, Legislative History. St Paul MN: West Publishing Co., 1982.

37. -------. "Senate Report No. 100-394," U.S. Congressional Code and Administrative News, 100th Congress, 2nd Session, Volume 7, Legislative History. St Paul MN: West Publishing Co., 1989.

38. ------. "House Conference Report No. 100-446," U.S. Congressional Code and Administrative News, 100th Congress, 1st Session, Volume 3, Legislative History. St Paul MN: West Publishing Co., 1988.

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The objective of this study was to determine if the ability of Air force organizations to contract with Small and disadvantaged Businesses (SDBs) depended on the type of contracting effort or the type of industry or product being contracted for. The type of contracting effort was broken down into four major categories based on the Federal Supply Classification (FSC) code. The type of industry or product was broken down into five major classifications based on the Supply and Equipment Classification (SEC) code. The data to support the analysis was gathered from the Air Force Systems Command (AFSC) for the years 1987 through 1989. the objective was accomplished through a statistical analysis which included a confidence interval analysis and a pairwise comparison of means. The results showed that the organization's ability to contract with the SDBs did depend on the two factors.

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